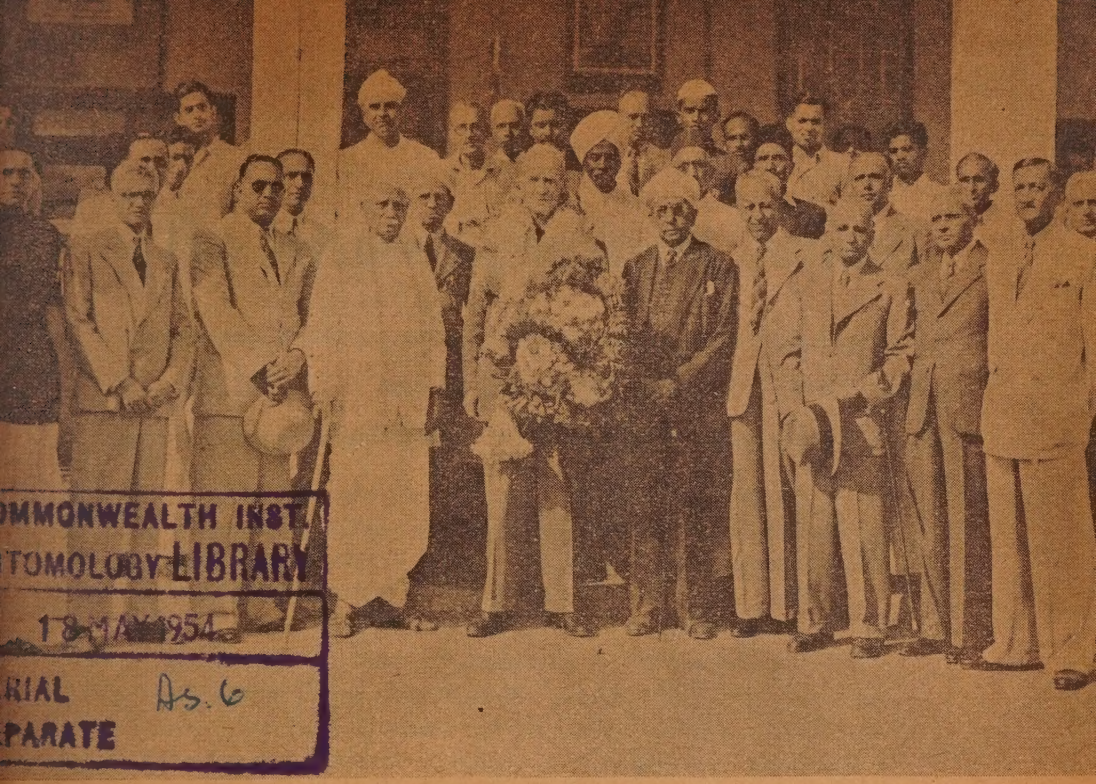

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The Mysore Agricultural Journal

(The Organ of the Mysore Agricultural and Experimental Union)

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ACHIEVEMENTS IN THE FIELD OF BIOLOGICAL CONTROL OF INSECT AND WEED PESTS

GROUNDNUT—FORAGE AND GREEN MANURE

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(The responsibility of facts or opinions rests with the several authors of the articles)

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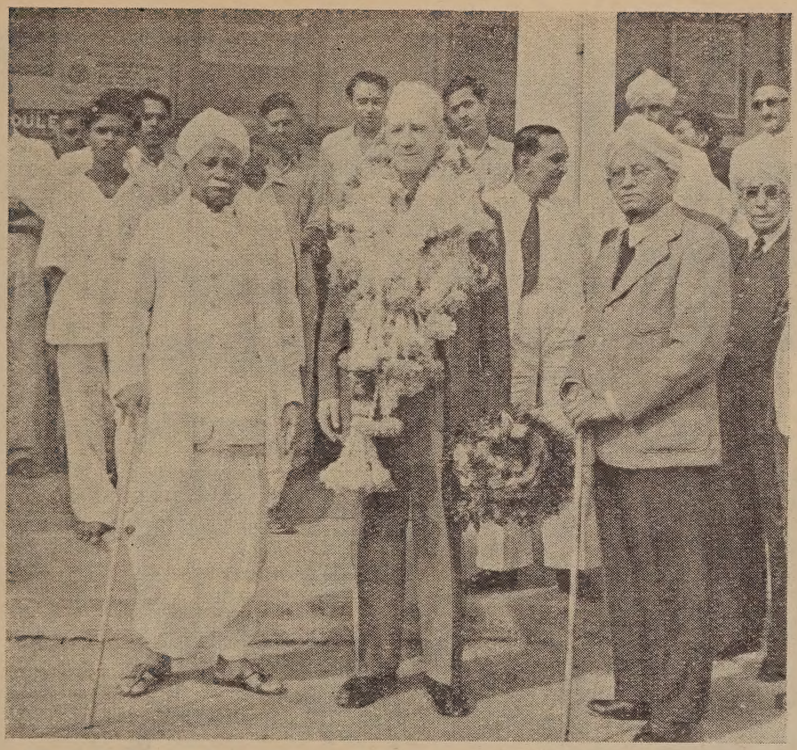

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K. H. Srinivasan; Dr. Leslie C. Coleman

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Left to Right: Dr. Leslie C. Coleman (first Director); H. V. Krishniah; A. K. Yegnanarayana Iyer; Dr. B. Narasimha Iyengar; M. J. Narasimhan; K. H. Srinivasan; M. K. Appajappa (present Director).

PADDY MANURIAL EXPERIMENTS

By B. Narasimha Iyengar, B.A., Ph.D.*

To find out manurial requirements of paddy crop, experiments in pots were started early in 1923. The soil used was got from paddy fields in the wet area of the Hebbal Farm. 34-days-old seedlings of Chintamani Sanna Bhatta were got from the Hebbal Farm and 12 seedlings were transplanted into each pot on 12th February 1923. The whole crop did not mature simultaneously and harvest took place on various days from 8th May to 26th June 1923. It might be interesting to note that plants manured with sulphate of ammonia or dried blood alone or with sulphate of ammonia and bonemeal failed to form any grain at all.

The plan of experiments together with average yields from 4 similarly treated pots is given in Table I. Manures applied were at the

Table I

Showing results of pot experiments

Treatment	Yield in grams per pot	
	Straw	Grain
No manure ..	22·75	9·3
Only ammonium sulphate ..	15·25	..
Only dried blood ..	43·00	..
Only groundnut cake ..	54·50	31·63
Only safflower cake ..	45·88	29·25
Only caster cake ..	65·25	56·38
Superphosphate only ..	39·25	34·25
Ammonium sulphate and super ..	118·25	103·25
Dried blood and super ..	87·83	73·05
Groundnut cake and super ..	110·63	85·03
Safflower cake and super ..	89·50	78·6
Castor cake and super ..	120·25	88·23
Bonemeal only ..	36·00	26·40
Ammonium sulphate and bonemeal ..	33·05	..
Dried blood and bone ..	62·00	42·5
Groundnut cake and bone ..	77·25	55·50
Safflower cake and bone ..	60·75	60·68
Castor cake and bone ..	81·75	83·63
Super and sulphate of potash ..	43·25	26·10
Super, potash and ammonium sulphate ..	127·75	102·25
Super, potash and groundnut cake ..	111·13	100·50
Bone and potash ..	29·75	17·00
Bone, potash and ammonium sulphate ..	50·25	..
Bone, potash and groundnut cake ..	84·50	44·00

N.B.—Manures were applied at the rate of 2 grams nitrogen, 3 grams of phosphoric acid and 2 grams of potash per pot.

* Director of Agriculture in Mysore (Retd.).

rate of 2 gm. N, 3 gm. P_2O_5 and 2 gm. K_2O per pot in various forms and were well mixed with the soil before it was puddled and seedlings transplanted. Each pot had a diameter of 10" and contained 15 kg. of soil. Care was taken to see that there was always 2-3" depth of water above the surface of soil in the pots.

The results obtained as judged from crop yields indicated that response to potash manuring was not adequate, that the use of phosphatic manures enhanced the utilisation of nitrogenous manures and that superphosphate was superior to bonemeal as a source of phosphoric acid.

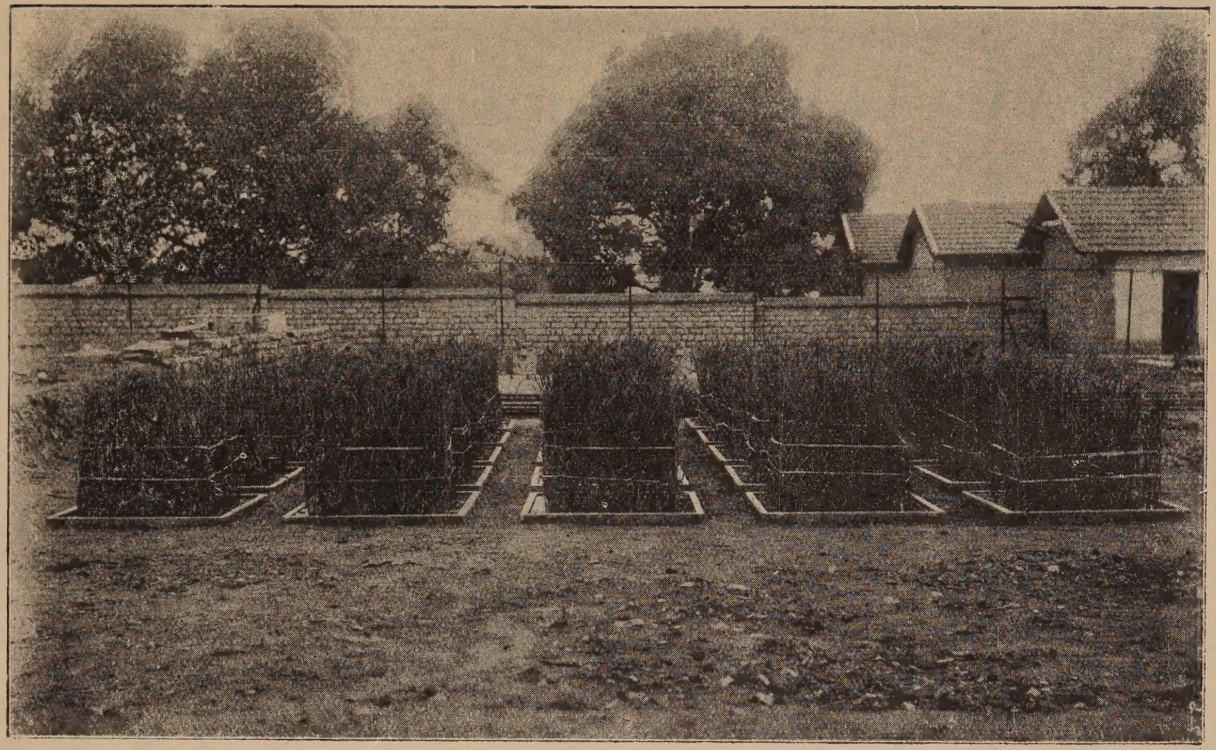
As field plots were not available on the Hebbal Farm to start work under practical field conditions, the next series of experiments was started in soil filled into bottomless reinforced concrete frames embedded in natural soil. While I was a student at the University of Goettingen, Germany, during 1913-19, I had seen such plots built out of brick and cement for work on potash manures. Similar frames were made here out of reinforced concrete. The frames enclosed a space of 1 square yard surface, were square in shape, and the sides were 6" deep. The thickness of frame walls was 1".

The frames were numbered and placed in position in 5 rows of five each with a space of 1' between the rows and between cisterns in the row.

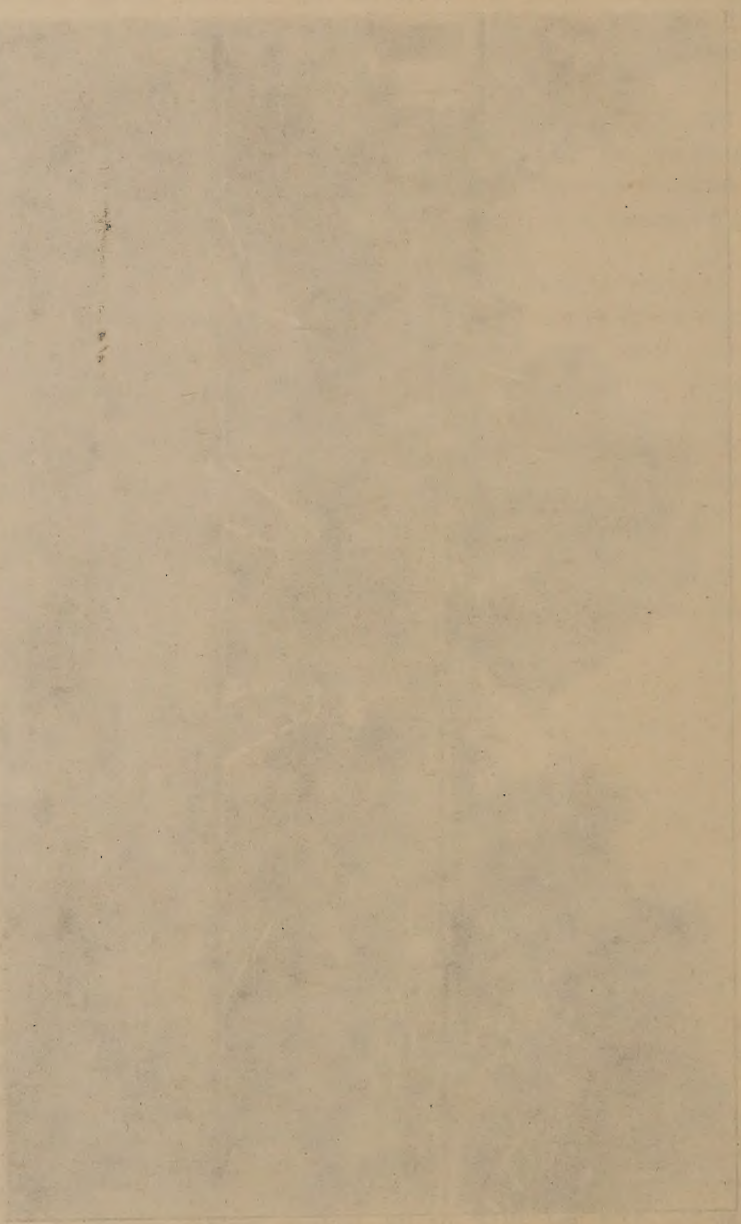
The exact location is indicated below.

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25

Well mixed paddy soil from paddy fields on the Hebbal Farm was filled into all the frames uniformly after removing the natural soil enclosed by the frames, and allowed to settle down into natural condition. The material was then puddled to imitate paddy field conditions early in February 1925. To study soil fertility under uniform conditions, each cistern was manured with 120 gm. of castor cake corresponding to 1,250 lb. per acre. In terms of nitrogen, the dose of manure applied worked out to 50 lb. per acre. 35-days-old paddy seedlings—variety Chintamani Sanna, were transplanted into each cistern in rows 4" apart with a spacing of 4" between seedlings in the rows also. Since 2 seedlings were always transplanted together there were 64 sets of double seedlings in each cistern. Field condi-



Experimental cisterns, pot culture House, Department of Agriculture



tions were imitated as far as possible with reference to irrigation. Earheads began to appear 46 days after transplantation. After a further period of 42 days, the crop was ready for harvest taking in all 123 days from seed-bed to harvest.

Crop yields from each of the similarly treated 25 cisterns are given in Table II. It is seen that in spite of all care taken in mixing

TABLE II

Showing yields of paddy from each cistern under uniform treatment

Cist. No.	Yield of crop in g.			Grain yield in lb. per acre
	Straw	Grain	Total	
1	230·0	230·0	460·0	2530
2	300·0	293·0	593·0	3220
3	253·0	228·0	481·0	2500
4	280·0	295·0	575·0	3240
5	225·0	251·0	476·0	2760
6	211·0	222·0	432·0	2440
7	298·0	301·0	599·0	3300
8	301·0	328·0	649·0	3800
9	250·0	213·0	563·0	2340
10	255·0	252·0	507·0	2770
11	247·0	224·0	471·0	2460
12	328·0	320·0	648·0	3520
13	275·0	270·0	547·0	2900
14	245·0	225·0	470·0	2470
15	270·0	300·0	570·0	3300
16	214·0	166·0	380·0	1820
17	282·0	324·0	606·0	3560
18	296·0	374·0	670·0	4110
19	258·0	269·0	527·0	2950
20	252·0	277·0	529·0	3040
21	254·0	220·0	474·0	2420
22	227·0	279·0	556·0	3660
23	269·0	296·0	565·0	3250
24	276·0	275·0	551·0	3020
25	260·0	212·0	472·0	2330

N.B.—(*a*) Each cistern was manured with 120 g. of castor cake equivalent to 50 lb. nitrogen per acre.

(*b*) 64 sets of double seedlings, 35 days old, were planted in each cistern from seed-bed to harvest, the crop took 123 days.

(*c*) 10 grams of grain per square yard = 106 lb. per acre or 60 seers by measure.

of the soil, filling the cisterns and uniform manuring, there is a variation of over 100 per cent. in corp yield. The yield of grain has varied from 166 g. to 348 g. per cistern on 1 square yard surface while the average yield of grain from all the cisterns works out to 250 g.

For regular experiments, the cisterns were grouped together and manured as follows :

Cistern Nos.	Average crop in g. per cistern	Treatment
7, 9, 17, 19	276·75	No manure
8, 18	336·00	Only nitrogen
3, 12, 14, 23	267·25	N and phosphoric acid
11, 13, 15	264·66	N, P and potash
5, 6, 24	249·33	Groundnut cake and super
4, 16, 25	224·33	Castor and bonemeal
2, 20, 21	263·33	Honge cake and bone
1, 10, 22	253·28	Groundnut cake and basic super

The dose of manure applied per cistern corresponded to 50 lb. nitrogen as ammonium sulphate or oilcake, 75 lb. phosphoric acid as super, bone or basic super and 50 lb. potash as a mixture of muriate and sulphate of potash.

The manures were applied each season just before transplanting using also the same number of seedlings each year. The crop was a monsoon crop grown between July and December. The requisite depth of water was maintained uniformly in each cistern throughout the period of growth.

The experiment was continued for 10 successive years from 1925 to 1935 and average yield of grain for the whole period from similarly treated cisterns is given below :

Yield of first crop per cistern	Later treatment	10 years average per cistern	Increase % on first crop per cistern
276·75	No manure	287·0	3·5
336·00	Only Am_2SO_4	403·4	20·0
267·25	N and super	459·5	71·9
264·66	N, P and potash	453·4	70·9
249·33	G-nut cake and super	399·6	60·0

Yields of grain from each individual cistern for every one of the 10 years of experiment together with other details are given in Table III.

Table III

Giving yield of grain from each cistern for each year of experiment

Cist. No.	Treatment	Year										Average 10 crops	lb. per acre
		1925–26	1926–27	1927–28	1928–29	1929–30	1930–31	1931–32	1932–33	1933–34	1934–35		
7	Check	368·0	328·0	434·0	251·0	64·0	380·0	232·5	221·7	166·0	240·0	268·4	
9	,,	401·0	379·0	317·0	398·5	135·0	465·0	458·5	178·0	216·0	233·5	317·1	
17	,,	382·0	198·1	290·0	329·0	110·0	412·0	408·0	185·0	178·0	194·2	230·4	
19	,,	376·0	428·5	307·0	129·0	132·0	453·0	458·0	335·0	218·0	287·5	332·4	
	Average	382·0	333·4	337·0	327·0	110·0	477·0	389·0	229·9	194·5	236·3	287·0	3042
8	N as Am_2SO_4	630·0	403·5	465·0	373·0	195·0	532·0	560·0	248·6	293·0	284·5	398·4	
18	,,	467·0	390·0	380·0	697·0	253·0	547·0	509·0	369·0	244·0	228·0	408·4	
	Average	548·0	396·8	422·5	535·0	224·0	539·0	535·0	308·8	268·5	256·2	403·4	4276
3	N and super	547·0	589·0	416·0	544·0	307·0	626·0	500·0	391·0	356·0	379·7	463·2	
12	,,	454·0	515·0	512·0	543·0	205·0	562·5	630·0	633·0	235·0	435·5	445·4	
14	,,	585·0	695·5	507·0	321·0	290·0	646·5	603·5	482·0	337·5	308·0	477·4	
23	,,	509·0	439·0	475·0	546·5	292·0	547·0	539·0	439·0	340·0	397·0	552·3	
	Average	524·0	559·6	477·5	489·0	273·0	594·0	568·2	418·7	312·13	380·2	459·5	4876
11	N, P and potash	510·0	432·0	539·0	453·0	222·0	528·0	406·5	331·0	321·0	357·7	407·0	
13	,,	491·0	538·0	497·0	337·0	205·0	619·0	716·0	397·5	290·0	325·0	441·6	
15	,,	522·0	465·0	545·0	626·5	320·0	725·0	621·0	496·5	341·0	457·0	511·6	
	Average	508·0	478·3	527·0	470·8	249·6	624·0	581·2	408·3	317·3	380·0	453·4	4806
5	G-nut and super	516·0	374·0	446·0	585·0	275·0	597·0	551·0	372·0	382·7	319·7	442·0	
6	,,	370·0	380·0	507·0	283·0	168·0	517·0	375·0	350·0	356·0	341·7	365·5	
24	,,	445·0	366·0	350·0	450·5	265·0	557·0	504·0	411·5	319·0	250·5	392·0	
	Average	444·0	373·3	434·3	439·5	236·0	557·0	480·0	377·8	352·6	303·7	399·6	4235

N.B.—1. During the first five years, Alur Sanna variety of paddy was used;
2. The crop of 1929–30 was after a summer crop of irrigated ragi;
3. During the last five years G.E.B.-24 variety of paddy was used.

From figures given above, it is seen that cisterns used for manuring with nitrogen only were much above the average while the others were only slightly above, the average grain yield per cistern under uniform treatment being 250 g. The last column of the statement gives the 10 years' average yield as increase per cent. of the first crop. While there has not been much variation in cisterns treated as check, the maximum increase has been from cisterns manured with nitrogen and phosphoric acid while groundnut cake is found to be slightly inferior to ammonium sulphate in its influence on crop.

Three other treatments were continued for only 4 years. Their results being comparable with application of groundnut cake and super, the results of 4 seasons only for the 4 treatments are summarized below:

First crop	Later treatment	4 years average crop per cistern	Increase over first crop per cent.
249·33	G-nut and super	423·0	70·0
224·33	Castor and bone	406·0	81·0
263·33	Honge cake and bone	445·2	70·0
253·28	G-nut and basic super	449·4	77·0

These results indicate that a mixture of castor cake and bone is slightly superior to other mixtures in its effects on crop yields. For use along with bonemeal, castor cake seems to be better than *honge* cake while a mixture of basic super and groundnut cake has shown itself as good as the mixture of castor cake and bone. Under conditions prevailing in paddy fields, there does not seem to be much difference in crop between the use of groundnut and super or *honge* and bone. The choice between mixtures may depend upon the price of materials needed for them.

Field Experiments.—Experiments for the trials of artificial manures on paddy with cattle or green manure and supplemented by artificials were started in 1923-24 on the Hebbal Farm. The plots used for work were either 1/20 or 1/40 acre in size and each treatment was repeated 4 or 5 times on the 1/20 acre plots and 6 or 4 times on the 1/40 acre plots. The larger plots were used for trials with cattle manure and the smaller ones for trials with green manure. Crop yields and other details are given in Table IV. Yield

TABLE IV

Hebbal Farm paddy experiments—yield of grain in lb. per acre

1905–06	1922–23	Treatment	Monsoon crop		Summer crop			Monsoon crop	Aver age 1923–30	Increase % over 1922–23	No. of repli-cations
			1923–24	1925–26	1926–27	1927–28	1928–29	1929–30			
2500	1440	C. M. 5000 lb. ..	2314	1870	1310	1300	1488	1621	1600	11·0	5
2830	1480	C. M. + 50 lb. Am_2SO_4 ..	2417	2172	2231	1460	1722	1523	1920	30·0	4
2515	1370	C. M. + N + P + 150 lb super ..	2440	2135	2180	1360	1762	1555	1905	37·0	4
2435	1420	C. M. + N + P 100 lb. K_2SO_4 ..	2537	2312	2340	1450	1600	1583	1970	39·0	4
	810	Honge leaf 6000 lb. ..	2347	2140	1560	1280	1299	1265	1650	100·0	6
	920	Honge leaf + G.-nut and super ..	2250	2140	1880	1520	1910	1721	1903	109·0	4
	825	Honge leaf + G.-nut and bone ..	2170	2190	1760	1340	1720	1676	1806	120·0	4
	820	Honge leaf + honge cake and super ..	2405	2340	1860	1360	1760	1788	1920	135·0	4
	820	Honge leaf + castor cake and super ..	2715	2320	1620	1480	1775	1636	1924	135·0	4
	825	Honge leaf + castor cake and bone ..	2555	2480	1810	1520	1725	1650	1960	140·0	4

N.B.—Artificials were applied at the rate of 10 lb. N., 25 lb. P_2O_5 and 50 lb. K_2O.

figures for 1905-06 when the plots had been given a uniform dose of castor cake and for 1922-23 when no manure had been applied are also given. Between these two periods all the plots were under some kind of experiment or other. Of the 5 experimental crops, the first two and the last were monsoon crops to which cattle or green manure had also been applied in addition to fertilisers while for the middle 3 summer crops only fertilisers had been applied. It is only the first 2 monsoon crops in the cattle manure series that are more or less of the standard of the first crop in 1905-06, while the remaining 4 crops are more or less similar to the no manure crop of 1922-23. Taking all the 6 crops together and comparing the average for each treatment with the corresponding average of no manure crops in the same plots in 1922-23, the results work out as follows :

Treatment	Crop of grain in lb. per acre		Increase % over first crop
	1922–23	Average 1923–29	
Only C–M ..	1440	1600	11·0
C–M and Am_2SO_4 ..	1480	1920	30·0
C–M and AM_2SO_4 and super	1370	1900	38·7
C–M and Am_2SO_4 and potash	1420	1970	38·7

Taking only crop yields into consideration, it is seen that while the application of cattle manure alone has yielded 1,600 lb. of grain on an average, the addition of a small quantity of 10 lb. of nitrogen as ammonium sulphate has contributed to an increase of 320 lb. or 20 per cent. while the addition of super and potash has not contributed to any further increase of crop. The reason may be that all the phosphorus and potash needed by the crop to make use of the extra small quantity of nitrogen was supplied by the cattle manure itself. Viewing the results in another way, *i.e.,* as increase over the no manure crop in each set of plots, it is seen that while cattle manure alone has given only a 11 per cent. increase, the other treatments have given an increase of over 30 per cent. In this way also, the increase over the cattle manure yields works out to about 20 per cent. the same as by the comparison of the treatments by themselves without reference to the first crop.

Coming now to the green manure series in which various paddy mixtures have been tried as a supplement to green manure at the rate of 6,000 lb. of *honge* leaf and twigs per acre, the yields work out as follows :

Treatment	Yield of grain in lb. per acre	
	Crop of 1922–23	Average of 1923–29
Only green manure ..	810	1648
G. M., G-nut cake and super ..	920	1900
,, G-nut cake and bone ..	825	1809
,, *Honge* cake and super ..	820	1920
,, Castor cake and super ..	825	1924
,, Castor cake and bone ..	825	1960

Judging the yields by themselves, it is seen that while green manure alone has given 1,648 lb. of grain per acre, the addition of fertilizers has increased the yield by slightly over 300 lb., or 20 per cent. approximately. Comparing the various mixtures, it is seen that while a mixture of groundnut cake and bone has given an increase of only 160 lb. of grain per acre over the green manure plots, the other mixtures have increased the crop by nearly 300 lb. The best yield has been from a mixture of castor cake and bonemeal.

Comparing the yields with the 1922-23 crop of the same set of plots, it is seen that in every case there has been an increase of over 100 per cent. whereas the increase in the cattle manure series was of the order of only 30 per cent. This may be due to the initial poor condition of the plots used for green manure series of experiments.

Experiments on the Nagenahalli Paddy Station were started in 1930-31 with a basal dose of only 1 ton of cattle manure per acre for all the plots. The differential manuring consisted of 30 lb. of nitrogen as sulphate of ammonia by itself or supplemented by 45 lb. of phosphoric acid as super and 20 lb. of potash as chloride of potash. The details of manuring and crop yields for the 5 experimental seasons are given in Table V. During the same years, varying doses of paddy mixtures as well as various sources of nitrogen were also tried and all results obtained are embodied in Table V. Figures for initial fertility of the plots before experiments were started are not available and so the yields from different treatments have to be compared by themselves.

While the soil on the Hebbal Farm is heavy clay under cultivation and tank irrigation for a long time, the soil on the Nagenahalli Paddy Station is gravelly in nature and brought under canal irrigation in 1920 or so.

The first series of experiments deal with general manurial requirements of the paddy crop. All the plots used for experiments have given their minimum yield in the first year and a maximum in the fifth year. The minimum, maximum and average for each of the treatments is as follows :

Treatment	Yield of grain in lb. per acre			Increase of % over C–M
	Minimum	Maximum	5 years aver.	
Cattle manure only ..	1311	2673	1970	..
C–M and nitrogen ..	1677	2968	2333	18·6
C–M, N and phosphoric acid	1965	3221	2427	23·2
C–M and potash ..	1918	2864	2333	18·6
C–M, N, P, K ..	2130	3136	2600	32·0
Average of all treatments ..	1922	3047	2423	..

It is seen from above figures that while a small dose of cattle manure alone has produced 1,970 lb. of grain per acre on an average, the addition of nitrogen has increased the yield by 18·6 per cent. Nitrogen and phosphate together have increased the yield by 23 per cent. while the addition of potash has raised the increase to 32 per cent. The yields also give an idea of how fertility of the land has been built up during the 5 years of manuring. While it has been possible to increase the crop from 1,311 lb. to 2,673 lb. by the application of cattle manure alone, the addition of nitrogen and phosphorus has raised the crop yield from 1,965 to 3,221 lb. Even when all the manured plots are considered together, it is seen that the average of the whole area has gone up from 1,922 lb. per acre in the first year to 3,047 lb. in the fifth year which means an increase of about 50 per cent.

In another set of plots, various doses of paddy mixture consisting of 150 lb. of sulphate of ammonia and 250 lb. of ordinary super were tried. In this series also, all plots received a basal dose of 1 ton of cattle manure per acre. The results obtained are given in Table V.

The plots used for these experiments have given better response to cattle manure than those in the previous series of experiments. The average yield in the present case is 2,337 lb. of grain per acre whereas in the other case it was only 1,970 lb. Viewed as percentage increase over the minimum crop in first year, it works out to 23 per cent. in the second set of plots whereas it was 50 per cent. in the first set. This seems to indicate that a soil in a better state of fertility to start with does not give the same increase in yield as another one

TABLE V

Nagenahalli Farm paddy experiments

Treatment	Yield of grain in lb. per acre					Average 1930–35
	1930–31	1931–32	1932–33	1933–34	1934–35	
Check ..	1311	1832	2265	1759	2673	1970
N only ..	1677	2288	2699	2031	2968	2333
N and P ..	1965	2127	2699	2120	3221	2427
N and K ..	1918	2191	2704	1987	2864	2333
N and P and K ..	2130	2462	3005	2269	3136	2600
Average of all treatments ..	1922	2267	2750	2102	3047	2423
Check ..	1896	1808	2859	2143	2178	2337
P M Single dose ..	2263	2244	2878	1730	3350	2500
P M 1½ dose ..	2514	2408	2808	2007	3533	2654
P M Double dose ..	2362	2641	2986	2120	3618	2745
P M 2½ dose ..	2764	2667	3245	1973	3650	2860
Average of all treatments ..	2360	2357	2955	1995	3426	2619
Check ..	1351	1514	2227	1678	2711	1900
Calcium cyanamide ..	1883	1859	2695	2136	3031	2320
Nitrate of soda ..	1543	2062	3061	1872	2861	2280
Ammonium sulphate ..	2167	2124	2471	2168	3459	2508
Groundnut cake ..	1896	2203	2530	2007	2806	2290
Average of all treatments ..	1770	1962	2597	1972	2973	2260

N.B.—1. All plots received a basal dose of one ton farmyard manure per acre.

2. Artificials applied corresponded to 30 lb. N, 45 lb. P_2O_5 and 20 lb., K_2O per acre.

3. Single dose of paddy mixture corresponded to 30 lb. N and 45 lb. P_2O_5.

Treatment	Yield of grain in lb. per acre		
	Minimum	Maximum	5 years average
Only cattle manure ..	1896	2978	2337
C–M and single dose paddy mixture	2263	3350	2500
C–M and 1·5 dose paddy mixture ..	2514	3533	2654
C–M and double paddy mixture ..	2362	3618	2745
C–M ond 2·5 paddy mixture ..	2764	3650	2860

in a comparatively poor condition. The average yield for a single dose of paddy mixture in both sets of plots is about the same, being 2,427 lb. in one case and 2,500 lb. in the other. Increased doses of paddy mixture have not given proportionately higher yields, though

they show an increase over the previous dose in every instance. Whether it is economical to apply more than 30 lb. N and 45 lb. P per acre is a point to be seriously considered.

A third set of plots were devoted to the trial of various nitrogenous manures, along with a basal dose of C-M and P. The cattle manure plots in this series have given an average crop of 1,900 lb. of grain per acre during the 5 years whereas in the first series of plots devoted to general manurial requirements, it was 1,970 lb. The results of this set of trials also are to be found in Table V. Of the various N manures tried, sulphate of ammonia has given the highest yield of 2,508 lb. of grain per acre. This very closely corresponds to yields from similar treatment in the other two series of experiments being 2,427 and 2,500 lb. of grain per acre respectively.

Experiments on the manurial requirements of paddy on laterite soils were conducted on then existing Marthur Farm for a number of years. Though there was good response to superphosphate and calcium cyanamide, the yield of crop per acre was rather low. Consequently, the figures have not been included in this note.

A comparative statement of yields from all manurial treatments on farms as well as large-scale demonstrations on private lands is given below :

Locality	Treatment	Average of all treatments in lb. per acre					Average of 5 years
		1st year	2nd year	3rd year	4th year	5th year	
Nagenahalli Farm	General manurial requirements	1922	2267	2750	2102	3047	2423
,,	Various doses P.M.	2360	2357	2955	1995	3426	2619
,,	Various forms of N	1770	1902	2597	1972	2973	2260
N-Farm 40 acres	Fym, Gm, 80 lb. Am_2SO_4, 170 super	2136	1905	2145	2525	2104	2180
Private lands 28 acres	Fym, Gm, 180 lb, G-nut cake, 140 super	1580	1663	1735	2288	2466	1950

Aduthurai Farm, Tanjore District. With 40 lb. N per acre :—2,000 lb. first year—4,000 lb. 20th year.
Green manure—1,350 lb. first year—2,900 lb. 5th year as reported in the "*Hindu*" of 2nd August 1953 and calculated for a single crop.

The figures show to what extent fertility of land can be built up by continuous manuring during a short period of 5 years.

A very detailed account of trials of fertilizers for paddy on private lands has been published in the *Mysore Agricultural Journal*, Vol. 23, No. 1, pp. 11-14. From figures given there, it is seen that

with a small dose of 15 lb. nitrogen and 25 lb. phosphoric acid per acre in addition to the small quantities of farmyard and green manure usually applied by cultivating tenants, the average yield of paddy grain which was only 1,580 lb. per acre in the first year doubled itself to 3,200 lb. in the course of 20 years. A similar experience of the yield getting doubled from 2,000 lb. to 4,000 lb. of grain per acre during a period of 20 years has been reported as results of experiments conducted on the Aduthurai Farm in Tanjore District, but the application of nitrogen was as high as 40 lb. per acre.

The Mysore Department of Agriculture has always been an advocate of balanced manuring for all crops. It is very gratifying to see that investigators in other States of India also have come to the same conclusion, and that steps to popularise the use of both nitrogenous and phosphatic manures are now being taken in all schemes connected with the Grow More Food Campaign.

This short note has been written with the main object of stimulating interest in food production schemes in the country.

The conclusions drawn are based on yield figures available and collected by me before retirement from service. If further figures are available in the departmental records, it may be quite useful to put them all together for publication to support or modify, if necessary, the conclusions arrived at on the basis of yield figures given in the note.

At the pre-Regional Conference of the F.A.O. of the United Nations, held in Bangalore recently, the Director of Agriculture, Madras, has touched upon the green manure problem connected with paddy cultivation and has described methods evolved in Madras for successfully tackling it. Methods are described as to how green manure plants can be grown along with paddy and after the harvest of paddy instead of trying to grow it before commencing paddy cultivation. The plant recommended is *Sesbania speciosa.*

The practice of growing green manures in paddy fields is a very old one in Mysore, specially in the channel tracts of the Districts of Mysore, Hassan and Mandya. A detailed study of the practice was made so far back as 1909 and a Bulletin on Green Manuring in Mysore was published in 1911 or so. How far the new practice evolved in Madras State can be followed in Mysore can only be found out by trials.

Dr. Lehmann, the pioneer of Agricultural Chemistry in Mysore, realised the great importance of green manuring of crops and planned out experiments on the Hebbal Farm for ragi crop also in 1907-08 before his retirement from service in Mysore. The experiments were continued for some years, results obtained reported upon in due course and embodied in the Bulletin on Ragi Cultivation in Mysore.

ACHIEVEMENTS IN THE FIELD OF BIOLOGICAL CONTROL OF INSECT AND WEED PESTS

By Dr. M. Puttarudriah, B.Sc. (Hons.), M.S., Ph.D. (Calif.)*

Biological control has been defined as "The employment of organisms for the control of population densities of animals and plants". It means "the maintenance of the population level of a species whether animal or plant below the economic threshold by the use of organisms". The whole concept of biological control is based on the principle of maintaining the population equilibrium when there is disturbance in the balance of nature, so that no one species continually increases or decreases in relation to the others in a given environment. Disturbance in the balance of nature occurs when a species is transferred from its native home where its equilibrium position is kept at a low level by its enemies and diseases, to a new habitat where such checks are absent. This results in the species becoming a pest. The introduction of these checks into the new habitat is a logical means of correcting this condition, and in many cases has proved very successful.

The equilibrium position is a theoretical population level—economic threshold, above which the organism is of economic importance. The density of the population of a species at equilibrium is determined by the rate at which the environmental resistance, or the mortality factor, *e.g.,* the natural enemy, is increasing with the density of the species—the pest. If the increase is rapid so as to reach the mortality level of 100 per cent. it reaches the equilibrium position at a lower density of the pest ; if the increase is slow it reaches the equilibrium position at a higher density. In biological control of a pest the slow increase of the natural enemy is steepened by artificial colonisation, which also helps in synchronization of the enemy and host populations. This also explains why a pest species is abundant in some places and rare elsewhere (H. S. Smith).

The principle biological factors which influence populations of species are insect predators and parasites, and microbial organisms like bacteria, fungi, virus, protozoa and nematodes.

Biological control is just nature's own method of control. Once the natural enemy is established it spreads by itself and maintains almost indefinitely. It does not endanger human health as insecticides often do ; nor does it involve the problem of insecticide residues or the breeding of resistant strains of pests.

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Many biological control projects have been worked successfully in different parts of the world. In U.S.A., Canada, Hawaii and West Indies particularly these projects have achieved remarkable success, mainly because most of their crop pests in those countries are introduced from elsewhere, either from the Orient or European Continent. Such introduced insects became pests there in the absence of the natural checks which kept them down in their native homes. Explorations for such checks in their native countries were later undertaken and suitable predators and parasites found there, were regularly taken over, mass-reared and introduced where and when necessary.

In India and other oriental countries the greater majority of the crop pests are indigenous and it looks as though there is, in many cases, an appreciable adjustment between the pest and the natural enemy. While entomologists are however examining the possibilities of deriving more benefit from such natural enemies, it is really difficult to greatly enhance the latter's usefulness and to achieve spectacular success with an indigenous natural enemy against a native pest. Yet there are instances of indigenous natural enemies which are found to become very important in certain places only, and not in others, under certain conditions.

It is very difficult to review the numerous biological control projects, handled all over the world, in this short space. But a few important projects where the natural enemies have become well established through artificial introduction may be cited.

Biological control of insect pests

The introduction of Vedalia, *Rodolia cardinalis* Muls, and *Cryptochaetum iceryae* (Williston) for the control of *Icerya purchasi* Maskell, the fluted scale, into California from Australia, by C. V. Riley, A. Koebele, Webster and D. W. Coquillett in 1889 was the first successful project which established biological control as a weapon of importance in the fight against insects injurious to agriculture. To-day fluted scale is no more a menace to citrus industry.

The fluted scale was found to have been introduced into South India (Nilgiris) in 1928. Y. Ramachandra Rao first introduced the Vedalia beetles imported from California and Egypt during 1929-30. Predators were mass-reared and liberated in the infested area which brought down the incidence of the pest. But after about 12 years there was again a recrudescence of the pest which had spread into Mysore. By the efforts of the Government of India, Vedalia was again imported in 1947 from California and colonised in Mysore State and other parts of South India. This important predator and the local species of *Rodolia* have checked the increase of the pest effectively.

Mealy bugs are exceptionally favourable for biological control. Apart from parasites, several species of coccinellid predators have been found to be effective agents. Of them *Cryptolæmus montrouzieri* Muls, introduced from Australia into California by A. Koebele in 1892 has saved the citrus industry from being destroyed by the citrus mealy bug, *Pseudococcus citri* (Risso).

This important predator has also been introduced into France, Italy, Egypt, Hawaii, Philippines and many other countries against citrus mealy bugs.

This predator was recently (1951) discovered in Mysore State by the Division of Entomology. It is found to be well established and very common wherever mealy bugs are found on guava, mango, citrus and ornamental plants. They were sent to neighbouring States like Madras, Coorg, etc. But for *Cryptolæmus,* mealy bugs would have been a major problem in Mysore.

The two giant coccinellids—*Synonycha grandis* Thumb, and *Anisolemnia dilatata* Fab, used in the biological control of sugarcane aphids in China and other Far Eastern countries, have also been recently found in 1951, by Mysore Division of Entomology, to feed upon bamboo aphids, *Oregma bambusicola* and *O. bambusæ*. Attempts are being made to utilise them, as also several other species of coccinellids in the control of aphids on groundnut and other field crops.

Another coccinellid, *Chilocorus nigritus* Fab, has been found to be useful against coffee green bugs, *Lecanium viride* Green, and hard scales of the genus *Aspidiotus.*

The hard scale, *Aspidiotus destructor* Signoret, reached Fiji in 1905 and became destructive to cocoanut plants. In 1928 spectacular success was achieved by Taylor in controlling it by importing a coccinellid predator, *Cryptognatha nodiceps* Mohl, from Trinidad.

The Japanese beetle, *Papillio japonica* Newman, became a scourge in U.S.A. in 1916. None of the indigenous parasites showed any promise. Then a party of entomologists led by C. P. Clausen explored the Orient countries and introduced a number of parasites in 1920. Of these, *Centeter cinerea* Ald, *Dexia ventralis* Ald, *Prosena sibirita* Fab, *Tiphia papillivora* Roh, and *T. vernalis* Roh, have become established.

The oriental fruit moth, *Grapholitha molesta* (Busek) was a menace on several kinds of fruit trees in U.S.A. The indigenous parasites, *Trichogramma minutum* Riley, *Macrocentrus ancylivorus* Roh, and *Glypta rufiscutellaris* Cress, were effective checks on this pest in New Jersey and Tenessee only. But in other places they did not multiply when introduced. So France, Italy, Australia and the

Orient were explored by G. J. Haeussler and R. W. Burrel in 1929, and parasites like *Ascogaster quadridentata* Wesm, *Perisierola angulata* Roh, and *Zenellia reseanæ* B.B. were introduced.

The forest pests, the gipsy moth, *Porthetria dispar* L, and the brown tail moth, *Nygmia phæorrhœa* Don, which were accidentally introduced into U.S.A. became a plague in 1889. A search for their parasites in Western Europe, Russia and Japan was undertaken by L. O. Howard and W. F. Fiske ; and later by W. R. Thompson and Timberlake, and sixty species of them were introduced. But the most important enemies of the gipsy moth are *Anastatus disparis* Ruschka, an egg parasite ; *Apanteles melanoscelus* Ratzeberg, on larva ; and *Calosoma sycophanta* Linn, a predaceous carabid ; and those of the brown tail moth are *Compsilura concinnata* Meig, *Sturmia nodicola* Townsend, and *Apanteles lacteicolor* Viereck. The project was reasonably successful, and was the largest and continuously active work supported by U.S. legislative appropriations.

In California two important pests of alfalfa (lucerne), a major hay crop, the weevil, *Hypera postica* Gyllenhall, and the caterpillar, *Colias philodice eurytheme* Boisd, are being controlled by *Bathyplectes curculionis* (Thompson), and *Apanteles medicaginis* Muesebeck, respectively. The weevil, first noted in 1904, spread rapidly to 11 States. Introduction of parasites was begun by U.S. Bureau of Entomology in 1911. W. F. Fiske, H. S. Smith, W. R. Thompson and later T. R. Chamberlain collected in Europe from 1911-14, many parasites; of which *Bathyplectes curculionis* introduced into California and Utah in 1933-34 proved effective against the weevil. The butterfly caterpillar, *C. philodice eurytheme,* a native insect was a serious economic pest. Of the several parasites noted on this pest, the braconid *A. medicaginis* was the most important in controlling it. A supervised control of the caterpillar pest has been developed by A. E. Michelbacher and R. F. Smith in 1946, and continued to protect the *Apanteles* parasite and to advise the cultivators in case of crisis.

The citrus black scale, *Saissetia oleæ* (Bern.) is being effectively controlled by mass releases of *Metaphycus helvolus* Comp, a parasite introduced from Africa in 1937 by H. Compere.

Many parasites have been introduced into California for the control of citrus red scale, *Aonidiella aurantii* (Mask.). The post-war introductions have been *Aphytis* sp, *Prospaltella* sp, and *Casca* sp, etc., from China in 1947 and 1949 by the University of California, Division of Biological Control.

Against the Citrophilous mealybug, *Pseudococcus gahani* Green, the *Cryptolæmus* predator was found ineffective in California, as it could not work at low temperature. C. P. Clausen explored China, New Zealand and Australia. In 1927 he found a paraiste, *Coccophagus*

gurneyi Comp, in Sydney and sent it to California. By 1930, outstanding control of the pest was obtained and it saved a million dollar to the State annually.

In Canada, the spruce sawfly, *Diprion polytomum* Htg, is being controlled by the introduction of the chalcid parasite, *Microplectron fuscipennis* Zett, from Europe.

In Fiji Islands several pests of cocoanut were controlled by natural enemies. Tothill, Paine and Taylor introduced from Malanesia in 1925, a parasite, *Ptychomia remota* Ald, a tachanid parasite and controlled the leaf-moth, *Levuana irridescens* Baker ; by this act of biological control, the copra industry was saved in the entire islands and re-established in Viti Levu. The leaf-mining beetle, *Promecotheca reichei* Baly, was successfully controlled by the introduction of *Pleurotropis parvulus* Ferrieve, from Java by Taylor and Paine. Simmonds introduced *Scolia oryctophaga* Coq, from Mauritius, Madagascar and Zanzibar in 1939 against the rhinoceros beetle, *Oryctes rhinoceros* Linn.; Lange introduced in 1947 *Tetrastichus brontispæ* (Ferrieve) into Saipan and Rota Islands in Fiji for the control of *Brontispa* sp. The parasite was so effective that Doutt in 1948 recommended replanting of cocoanut in the Islands.

The Mediterranean fruitfly, *Ceratitis capitata* (Wied.) and the melonfly, *Dacus cucurbitæ* (Coq.) have been successfully controlled in Hawaii, by *Opius humilis* Silv, and *Diachasma tryoni* Cam, introduced from West Africa on the former by Silvestri and *O. fletcheri* Silv, from India on the latter by Fullaway in 1916.

The oriental fruitfly, *Dacus dorsalis* Hendel, has been a menace in Hawaii, being a war-time introduction, and is causing concern to U.S.A. because of its potential threat to fruit industry in California. Several agencies like the Federal Government, State of California, University of California, University of Hawaii, etc., have joined hands in a combined project to stop this scourge in Hawaii. Explorations for suitable parasites are done in India, Malaya, Africa and other countries. Several species of the parasites of the genus *Opius* have been introduced into the Island from India, and the results have been encouraging.

In Hawaii the control of sugarcane leafhopper, *Perkinsiella saccharicida* Kirk, has been an outstanding success by the parasite, *Ootetrastichus beatus* Perk, and the predaceous bug, *Cyrtorhinus mundulus* Bredd, introduced from Fiji, the former by Albert Koebele in 1905 and the latter in 1911 by Muir and Pemberton.

In Barbados, the sugarcane moth-borer, *Diatrea* sp. is being checked by the native egg parasite *Trichogramma minutum* Riley, by mass rearing and periodic colonizations (Tucker). In addition, the tachinid

fly, *Lixophaga diatrea* Town, and the Amazon fly, *Metagonostylum minens* Town, are also important.

In India, Mysore Division of Entomology did the pioneering work of etablishing a parasite laboratory for mass rearing of locally occurring *Trichogramma* in the sugarcane tract of the State in 1935 ; millions of these minute wasps are being reared and released annually against the moth-borer, *Argyria sticticrapis* H. Though *Trichogramma* has not proved quite effective in other parts of India, it is found to be very useful in Mysore State in controlling the seedling borer when coupled with a cultural operation of light earthing up of young cane.

Tetrastichus sp. and *Phanurus beneficiens* Zehnt. have been found to destroy a large percentage of the eggs of the top borer moth, *Sirpophaga nivella* W. These indigenous parasites are being recovered from the egg masses, and released again in sugarcane fields where their incidence is low.

Pleurotropis foveolatus is another native parasite which takes a heavy toll of *Epilachna viginti-octo-punctata* (Fabr.), a serious pest of potato in Mysore State. Attempts are being made to mass rear them and colonise them in the fields ; as also, *Microbracon hebetor* S, another important parasite, for the control of *Avare* pod borer, *Adisura atkinsoni* M.

In Madras State, according to Y. R. Rao and others, *Nephantis serinopa* Meyr, a serious pest of cocoanut leaves, is being controlled by liberations of cage-bred indigenous parasites, *Trichospilus pupivora* Ferr, *Perisierola nephantidis* Mues, *Elasmus nephantidis* Roh, and *Microbracon brevicornis* Wesm, in bulk during 1926-30.

In Punjab, *Aphelinus mali* Hald, was successfully introduced from England during 1937 by M. Afzal Hussain, against *Eriosoma lanigerum* Hausm, a serious pest of apple trees, and has now been established in the Kulu Valley.

Agricultural Research Institute, New Delhi, imported *Microbracon gelechiæ* Ash, from the United States of America during 1944-45, for controlling *Gnorimoshema operculella* Zell, the potato tuberworm, a serious pest of potato, both in the field and in store.

In the biological control of the Japanese beetle, *Popillia japonicum* Newm, the most prominent factor has been the milky disease caused by the bacteria *Bacillus popilliæ* Dutky, and *B. lentimorbus* Dutky, in the north-eastern part of the United States. A spore manufacturing plant of this bacterium is established by the U.S. Department of Agriculture for extensive distribution of the disease. "From 1939 to the end of 1948, a total of 151,559 lb. of sporedust was used to treat 90,791 sites covering 73,618 acres in 12 States and the District of Columbia." In addition several commercial agencies are marketing the product under their own trade names, so that cultivators have been

able to distribute the spores on their own fields. Marked reductions in the Japanese beetle grub population have occurred in the treated areas.

Glaser and Chapman observed during 1912-16 that the forest pest gipsymoth, *Porthetria dispar* L, was largely subjected to polyhedrosis, the virus disease. A virus disease, inadvertently introduced with the parasites, has been a major controlling agent against the spruce sawfly, *Diprion polytomum* Htg, in the forests of Canada. Balch and Bird in 1944 presented evidence that this disease was responsible for the great reduction of this destructive insect on spruce. Michelbacher and Smith in 1943 reported that a similar Polyhedrosis disease was the most important natural check on the alfalfa (lucerne) caterpillar, *Colias philodice eurytheme* Boisd, in California. Steinhaus and Thompson have carried out extensive experiments with this virus on the alfalfa caterpillar during 1949-51 and have been able to spray by airplane, cultures of this virus disease, in the control of this pest.

Biological Control of Weed Pests

The importation of the cochineal insect, *Dactylopius tomentosus* L, from Ceylon in 1927 by Mysore and Madras Division of Entomology and its establishment permanently in the States of Mysore and Madras for the destruction of pirckly pear, *Opuntia dillenii* Haw, and *O. nigricans* Mill, which had invaded into millions of acres of arable land and forest areas marked a definite milestone in biological control of noxious weeds. The result has been spectacular, in that impenetrable bushes over wide areas in the States were thoroughly cleared and the land rendered useful to the cultivators.

In Australia, 60,000,000 acres of land rendered unfit by another species of prickly pear, *O. monacantha* Haw, were recovered by the Commonwealth Prickly Pear Board by the use of the moth-borer, *Cactoblastis cactorum* (Berg.) introduced from Argentina by 1940.

In U.S.A. effective control of St. Johns wort, *Hypericum perforatum* L, serious menace to range lands is being achieved by the two Chrysomelids, *Chrysolina hyperici* Forst, and *C. gemellata* Rossi, introduced from Australia by the U.S. Bureau of Entomology.

W. M. Davies reported in 1928 that gorse, *Ulex europæus* L, has been controlled in New Zealand, by the seed weevil, *Apion ulicis* Forst, imported from England and France.

Lantana was a scourge in Hawaii, as it is in India. Several insects were introduced for its destruction from Mexico by A. Koebele in 1902. Of these, the fly, *Agromyza lantanæ* Frogg, *Crosidosema lantanæ* Busck, and *Teleonemia lantanæ* Dist, are important. But they were effective only in the drier parts of the island and so, success was partial. Attempts were made by the Mysore Department of Agri-

culture to introduce these *Agromyzid* flies from Hawaii in 1921 and 1933, but no success could be obtained. Though recently in 1933, the *Agromyzid* fly was found to have established in Mysore and some other parts of India, it has not proved to be effective in destroying the lantana weed, which has invaded thousands of arable land and forest areas. This problem requires reinvestigation.

In conclusion, it may be stated that biological control work requires laborious study and patient work. To get any success, a clear conception of the many phenomena of hyperparasitism, superparasitism, multiple parasitism, searching capacity, reproduction, sex determination, nutrition, respiration, host preferences of the natural enemies ; economy of parasitism—egg production and disposal, etc., must be had. Insect ecology must be thoroughly studied. Time, money, energy, sympathetic appreciation by the Government and the public are necessary for getting practical results. Fundamental research must be carried out and secure foundation built up before going with cultures into the fields.

First phase of biological control work has been done with parasites and predators. Now the use of micro-organisms is coming more and more into the field. Microbial control is complementary or supplementary in biological control work.

There is a mistaken idea that biological control works in opposition to chemical control. But care must be exercised in the use of insecticides to prevent the harmful effects on the natural enemies. All methods of control must be combined as their common aim is to check the pest.

Biological control is not usually appreciated ; but large applications of it are made in Australia, Hawaii, U.S.A. and other countries. Yet biological control must be ruled out for some insects. It ought to be a long range policy. Building up of the pest and the natural enemy must be watched, and colonizations of the latter must be made from the early stages ; and not when the pest reaches the climax. It must be clearly understood that biological control aims at regulation and not reduction, so that the pest does not rise above the economic level. Biological control cannot be recommended at crisis, however efficient a natural enemy has already proved. As it is a question of saving the crop when the pest has multiplied to its destructive proportions recourse must be had to insecticides, because it is very uncertain how the natural enemy would behave and respond in a new ecological set-up.

If properly worked, many insects can be controlled by this method, and it will be really useful ; but the attitude of the workers in this field must be, in the words of E. A. Steinhaus, that of "hopeful conservatism".

GROUNDNUT-FORAGE AND GREEN MANURE

By K. Gopala Iyengar*

Groundnut has risen to a position of phenomenal importance quite recently. At present, it is grown over an area of 3 lakhs of acres in Mysore. It is the major oilseed of the State and is of foremost importance as a cash crop to the farmer of drylands. Apart from the well-known uses to which the crop is put into, it also provides green matter of considerable forage value. Sometimes, the green matter or *haulms* are used as a green manure. On an average, yields of 2,000-3,000 lb. per acre of *haulms* are obtained from a dry crop. In a few places, the *haulms* are cured and stacked in alternate layers with paddy straw. This wholesome practice of using the *haulms* is by no means universal. Frequently, the plant dries up at maturity shedding most of the leaves. Being a legume, the vegetative portion is rich in protein[3] as compared with that of millets and cereals. A little success achieved in this respect, has been reported upon preliminarily.[2]

Most of the investigations on this crop alluded to already, were started in 1913 by the late Dr. V. K. Badami on the Hebbal Farm near Bangalore. The programme involved extensive hybridization employing 33 varieties as parents. In many cases, individuals appeared in F_2 having a vigour greater than either of the parents. This vigour was often lost as retained in subsequent generations. Usually, these vigorous types either set poorly or bore pods of very small size. These small-seeded or pigmy types were reported by Badami[1] as being vigorous growers and under multiplication for fodder. Since 1939, a large number of these vigorous hybrid progenies have been under trial at Hebbal. The object aimed at in these trials was to remove the defects of poor bearing and reduced pod size while retaining the desirable feature of vigorous top growth.

The number of such progenies under trial was 69 in 1939. After several trials this was reduced to 20, two years later. In 1946, 11 of the abovementioned progenies were taken on to preliminary yield trials. Subsequent trials bore out the superiority of 2 progenies, which were designated as H.G.5 and H.G.6 respectively. These have been multiplied and made available for trial on an extensive scale. Both H.G.5 and H.G.6 are long-duration bunch types, taking nearly

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5 months to mature. They are hardy, resistant to drought, tolerant to *tikka* leaf-spot, and retain the bulk of the leaves till harvest time. The yield compares favourably with commercial types of the same category. H.G.5 resulted from a cross between the old spreading variety, Mysore local and Spanish. Many of the side branches in this are partly trailing, resulting in a loose, semi-compact habit. The pods borne are small, two-seeded, the shell surface boldly net veined, and the kernels flesh coloured. A progeny of the cross between Virginia and Small Japan gave rise to H.G.6. It has a compact habit and bears two-seeded pods of a large size. The pods are often deeply constricted and slightly mis-shaped, with flesh coloured kernels. The performance of these varieties on the Hebbal Farm was as follows :

Variety	H.G.5	H.G.6
Average yield of pods in lb. per acre ..	610	551
Per cent. yield of H.G.1—Control ..	141	128
Weight of pods per litre in g. ..	328	332
Shelling % ..	75	70
Weight of kernels per litre in g. ..	679	628
Number of kernels per kg. ..	3311	1647
Oil content % ..	49	49
F.F.A. % ..	0·49	0·36

The yield of pods, represents a definite increase over H.G.1—the old standard variety. The seed size is a desirable feature of H.G.5 for purposes of green manuring since a unit weight of kernels will result in a greater number of individual plants. H.G.6 has the largest kernel size of any improved variety. The number of kernels per kg. are respectively 1,647 in H.G.6, 2,384 in H.G.1, 2,575 in T.M.V.3 and 3,537 in Spanish. The bold kernels make this out into an attractive table variety.

The weight of *haulms* obtained varied from 3,000-7,000 lb. per acre, depending on the conditions of growth met with, favourable or otherwise. The composition of the green matter was :

Variety	H.G. 5	H.G.6
Average yield lb. per acre	5,420	5,936
Moisture %	67·33	64·68
Ash %	5·53	5·75
Insoluble residue in HCl %	0·61	0·47
Crude protein %	10·00	11·87
Fibre %	28·49	33·87
N free extract %	63·47	57·50
Ether extract %	0·91	0·96
N %	1·60	1·92
CaO %	1·68	1·65
P_2O_5 %	0·50	0·56

The *haulms* were allowed to partially dry in the open and was then stacked and allowed to cure. After the expiry of 3 months, it cured into a rather dark-coloured hay, which was found to be highly acceptable to cattle. In curing, it was found advantageous to handle the produce early in the day and that too as little as possible. Frequent handling in dry weather resulted in the breaking of tips and shedding of leaves. The cured hay was found to contain :

Variety	H.G. 5	H.G.6
Ash %	5·67	5·70
Residue in HCl %	0·71	0·59
Crude protein %	9·06	11·18
Fibre %	34·68	28·74
N free extract %	57·27	62·79
Ether extract %	0·93	0·92
N %	1·45	1·79
CaO %	1·64	1·63
P_2O_5 %	0·50	0·52

The chemical composition indicates the *haulms* and hay to be superior in feeding value to that of cereals and millets. Among legumes while it is inferior in value to lucerne, it is nearly as good as that

H.G 5

H.G. 6

of berseem or cowpea.[3] While proving to be a good source of N it is also fairly rich in CaO and P_2O_5.

The long duration of the crop restricts the cultivation of these varieties to favoured localities which normally experience the benefit of both the monsoons. To obtain high yields of pods as well as *haulms,* it is necessary to grow these on fertile soils, which are highly retentive of moisture. On Visweswaraiah Canal Farm near Mandya, yield of both pods and *haulms* has been two times more than obtained at Hebbal.

Part of this investigation was financed by the Indian Council of Agricultural Research and later on by the Indian Central Oilseeds Committee. Thanks are due to the Agricultural Chemist under whose guidance the analytical work was carried out.

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EMPOASCA DEVASTANS DISTANT— A LITTLE KNOWN POTENTIAL INSECT PEST IN MYSORE

By S. Usman*

Introduction

During May-June 1953, leafhoppers of the genus *Empoasca* Walsh (Cicadellidæ, Hemiptera-Homoptera), were found breeding in large numbers on brinjal (*Solanum melongena*) in Chickballapur, Kolar District. These have been determined as *E. devastans* Distant, although an examination of a further batch of specimens seems to suggest that more than one species may be involved. Except for a solitary record by Husain and Lal (1940) of the occurrence of *E. devastans* based on collections made by Subramanian‡ on cotton, no information on this insect from Mysore exists in literature.

Economic History

In India *E. devastans* is economically by far the most important from among two dozen species of *Empoasca* known. Distant described this species in 1918 as a serious pest of cotton in Nagpur. Fletcher (1920) recorded it as a bad pest of cotton, particularly of exotic varieties in various localities in India. In 1940 Husain and Lal report regarding its economic importance thus : "This species came into prominence over 25 years ago when it was found attacking the American varieties of cotton then newly introduced in the Punjab. Later, the failure of 3 F cotton in the same province in 1913-14 was mainly attributed to Jassid attack and it was obvious that *E. devastans* was the species involved. Since then several more outbreaks of this pest of a serious nature have occurred." In subsequent years also this insect has been the subject of study by various workers, particularly in the Punjab and Madras.

Husain (1930) stated that *E. devastans* causes leaf-crinkle of cotton in the Punjab. Thomas and Krishnaswami (1939) report it as a vector of "Little Leaf", a transmissible disease of brinjal (*Solanum melongena*) that causes a gradual diminution in size of the leaves and the suppression of the reproductive phase in the plants in Coimbatore.

It will, therefore, be evident that *E. devastans* is a dangerous insect full of potentialities of becoming a very serious pest, and also acting as a vector of diseases.

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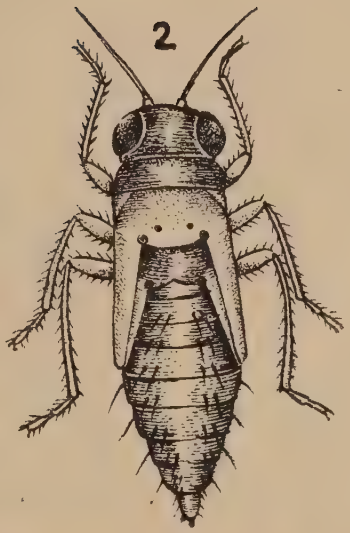

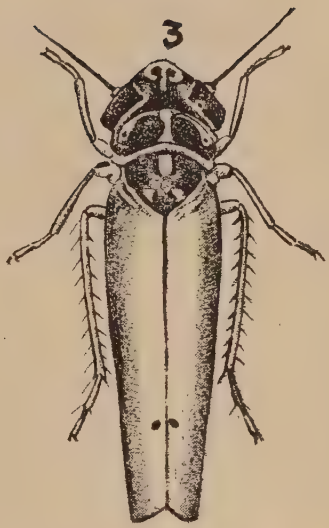

Empoasca devastans Distant

Fig. 1. Egg (×25). Fig. 2. Nymph (×25). Fig. 3. Adult (×15). Fig. 4. Leaf damaged by hoppers (1/3 natural size). Fig. 5. Nymphs and adults on leaf (lower surface)-(enlarged).

Host Range

E. devastans has been observed to breed on brinjal (*Solanum melongena*) and cotton ; adult hoppers were also obtained on *bhendi* (*Hibiscus esculentus*) and some Cucurbits, on which immature stages have, however, not been noticed.

Husain and Lal (1940) report the following additional host plants: *Ban kapas* (*Hibiscus vitifolius*), *Gogu* (*H. cannabinus*), potato (*Solanum tuberosum*), hollyhock (*Althæa rosea*) and castor (*Ricinus communis*). Cherian and Kylasam (1938) record sunflower (*Helianthus annuus*) as a host in Madras.

Nature and Extent of Damage

E. devastans causes considerable damage by desapping the leaves. Husain and Lal (1940) and many other workers suspect that this species, in addition to causing injury by feeding, also injects a toxin into the leaf-tissues resulting in the browning, crumpling and withering of the leaf. The extent to which plants suffer depends on the degree of infestation ; in badly infested brinjal plants no less than 86·3 nymphs and adults on an average, were observed on each leaf, and naturally in a general infestation of this extent the injury by feeding alone would be quite substantial and would noticeably inhibit normal functioning of the leaves. Plants so infested appear pale and sickly.

The insects confine their feeding to the under surface of leaves entirely. The first indication of injury is the appearance of yellow spots on the upper surfaces of the leaves. As feeding continues these spots become larger and more numerous until the leaf shows a general mottling, accompanied by a curling of the lamina with brown necrotic patches. Ultimately the leaf becomes a dull red colour with narrow strips of yellowish green along the veins (Fig. 4).

Life-History and Habits

Eggs (Fig. 1) (0·7 mm.) elongated, slightly pointed at both ends, greenish yellow in colour ; laid singly in the leaf-veins.

Just-hatched nymphs (0·8 mm.) are transparent, changing soon to white, and after feeding for sometime becoming tinged with green ; eyes conspicuous, red. As development proceeds the wing pads appear (Fig. 2) and extend to the full length. Early stage nymphs are inactive, generally gregarious and are found feeding on the under-surface of leaves.

The adult hoppers (Fig. 3) (2·25 mm.) are yellowish green with greenish eyes, and have a prominent black spot on each tegmina.

All the stages of *E. devastans* are found on the brinjal leaves. Brinjal plants, both in the pre-flowering and bearing stages, are equally susceptible.

The development of 10 individuals from egg to adult was studied on brinjal leaf from 24th May to 30th June 1953.

Duration in days of developmental stages during May-June 1953 *at a temperature ranging from* 61° *F. to* 95° *F.*

Stage	Duration in days		
	Maximum	Minimum	Average
Egg ..	8	5	6·2
Nymph ..	26	17	21·3
Total ..	34	22	27·5

The actual number of instars could not be observed. Husain and Lal (1940) record 5 instars, which is the usual number of nymphal instars in the genus *Empoasca.*

Control

It is highly significant that no parasites of *E. devastans* appear to be on record ; nor are any effective predators known.

Husain and Lal (1940) report that in trials in the Punjab hand-netting and use of light traps gave negative results, rosin soap spray was successful on a small scale and dusting with calcium cyanide with wood ash (1 : 8) gave 90 per cent. kill of hoppers but was expensive. Cherian and Kylasam (1938) record very good results against adults and nymphs with nicotine spray in Madras. A more promising kind of approach, in the case of an extensive crop like cotton has, however, been to evolve Jassid-resistant varieties, and some success has been achieved in this work in India (Afzal and Abbas, 1943).

On brinjal plants, on which *E. devastans* is so common and so numerous, the pest may be effectively controlled by spraying either tobacco decoction (1 lb. tobacco in 8 gallons of water + ⅛ lb. soap) or Geigy's DDT-Guesarol-550 (1 lb. in 16 gallons of water), the latter treatment being more lasting.

Acknowledgments

I am very thankful to the Director, Commonwealth Institute of Entomology, London, for the identification of the species. Thanks

are also due to Sri. P. R. Raghuram Pillai, Artist, Department of Agriculture, Bangalore, for the drawings.

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P.S.—The author has since noticed this Cicadellid breeding in large numbers on cotton in Davangere and Sirguppa during December 1953.

SOME NEW HOSTS AND CONTROL OF THE COMMON BLISTER BEETLE

By S. Usman*

The common blister beetle (*Mylabris pustulata* Thunberg) (Coleoptera, Meloidæ), is distributed throughout India, Burma, Ceylon, Java and East Indies, and is a sporadic pest of garden, truck and field crops. The blister beetles are often classed as beneficial in view of the habit of the early stage larvæ to feed upon the eggs of grasshoppers;[2,3,10] but, when as adult beetles, they attack plants in destructive numbers (see Fig.), control measures are necessary.

Host Plants.—Hutson[7] has recorded *M. pustulata* on *Cajanus* in Ceylon; Shroff[11] noticed it on flowers of *Dolichos lablab, Phaseolus mungo* and other pulses in Burma; and Van Der Goot[13] obtained it on *Glycine hispida* in East Indies. In India Lefroy[9] observed it feeding upon the flowers of Cucurbitaceæ such as the melon, pumpkin, cucumber and white gourd. Fletcher[4] includes among its hosts, flowers and tender shoots of cotton, *gogu*,† redgram, groundnut, cowpea, lablab, wild Ipomœas, prickly pear, garden species of Hibiscus, rose plants and sometimes earheads of cereals like *cumbu, tenai* and *jola.* Subramaniam[12] records it from Mysore on the flowers of *Rosa sinensis, Hibiscus esculentus* and Cucurbitaceous plants in general. *M. pustulata* has been noticed recently on the following additional economic plants in Mysore State :

On Flowers

Leguminosæ.—*Phaseolus vulgaris* L., *Cassia angustifolia,* Vahl., *Crotalaria juncea* L., and *Pongamia glabra* Vent.; Cucurbitaceæ—*Trichosanthes anguina* L., *Lagenaria vulgaris* Ser., and *Cucurbita moschata* Dunch.; Convolvuaceæ—*Ipomœa* spp.; Cruciferæ—*Raphanus sativus* D., and *Brassica nigra* Koch.; Rosaceæ—*Pyrus malus* L.; Verbenaceæ—*Lantana aculeata* L. ; and Solanaceæ—*Solanum melongena* L. Beetles were found on *S. tuberosum* L., but actual damage was not noticed. Blister beetles are a serious pest on potato in the United States.[5,6]

On Tender Leaves and Earheads

Eleusine coracana, Gaertn. (Graminæ).

Two more allied blister beetles were obtained on this crop, *viz., Gnathospastoides rouxi,* Cast. and *Lytta actæon,* Cast.

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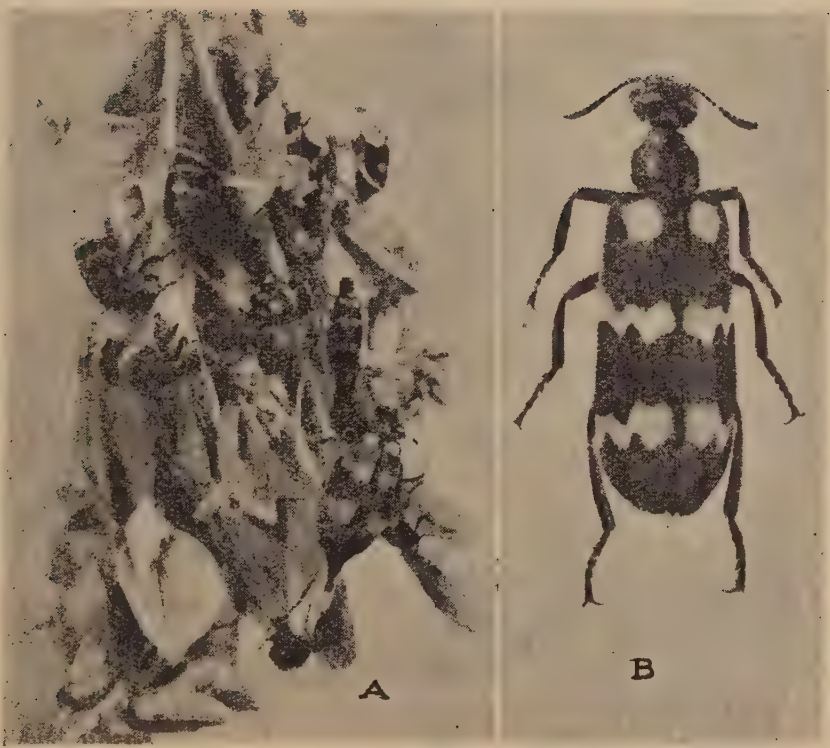
† *Gogu* or *Pundi* (*Hibiscus cannabinus*) ; *Cumbu* or *Sajje Bajra* (*Pennisetum typhoideum*) ; *Tenai* or *Navane* (*Setaria italica*) ; Jola or Jowar (*Sorghum vulgare*).—Ed.



A. Blister Beetles Feeding on *Crotalaria* sp. B. Blister Beetle (Enlarged).

On Fruits

Anacardium occidentale L. (Anacardiaceæ).

Large numbers of beetles were found feeding on ripe cashew fruits. This seems to be the first record of this pest damaging ripe fruits, although Verbeek[14] considered its possibility in Java as long ago as 1930.

Control Measures.—Brittain[1] reports that *M. pustulata* is susceptible to calcium cyanide dust in Ceylon. Fluosilicates or Rotenone-bearing dusts and sprays with Arsenates, Bordeaux mixture + Paris Green, Pyrethrum, etc., have been used in the United States against the blister beetles with varying degrees of success.[5,6] Krishnamurti and Appanna[8] recommended 5 per cent. DDT or Gammexane D.025 dust against this pest. In further laboratory and small-scale field trials conducted here 5 per cent. Hexyclan dust (a Vander Lee product) or a spray with DDT Guesarol 550 (Geigy's)—1 lb. in 20 gals. of water—has been found equally effective. However, hand-picking or netting must be employed against beetles infesting ripe edible fruits.

Grateful thanks are due to Sri. B. Krishnamurti, Government Entomologist, for guidance and encouragement.

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SOME OBSERVATIONS ON THE NATURAL CONTROL OF THE RED SPIDER MITE, *TETRANYCHUS TELARIUS* LINN. (ACARINA, ARACHNIDA)

By Dr. M. Puttarudriah and G. P. Channa Basavanna*

Tetranychus telarius Linn. is a widely distributed species infesting a large variety of both cultivated and uncultivated plants. Ayyar (1940) has reported that this mite is a serious pest on castor, ganja (*Cannabis sativa*) and numerous other plants in South India. Janjua (1942) has recorded the species from Baluchistan giving its host range and life-history, including the natural enemies of the mite. The writers have found infestations by the mite around Bangalore, on a variety of plants, like castor, groundnut, pumpkin, cucumber, cotton, cowpea and *avare* (*Dolichos lablab*). Occasionally heavy infestations on some of the above hosts were noticed especially during the warm periods of May to August months, but substantial damage to the infested crop was apparent very rarely. The adult mite is red in colour, though slight variations like greenish, pinkish or yellowish-pink are met with, and is a profuse web spinner, and infested plants and even the ground beneath may be completely covered with the webs. Commonly all stages—eggs, young ones and adults of the pest are found together underneath a delicate web on the lower surface of the leaves. Due to the feeding activity of a large number of individuals on the lower surface of leaves, thin-leaved host plants, like castor, cowpea, cotton, etc., show pale-yellow patches on the upper surface of affected leaves ; plants like cucumber and pumpkin with thick leaves do not exhibit any such patches on the infested leaves, but the leaves become roughened and stunted in growth, in cases of heavy infestation.

Among the more common of the natural enemies of the citrus red spider mite and other allied mites, Quayle (1912) has listed not less than seven species feeding upon different stages of the mite. Janjua (*loc. cit.*) has reported *Adalia decempunctata* L. and a species of *Chrysopa* as predaceous on the mite at Quetta, but not sufficient to afford much control. During the present observations the mite was almost always found in association with one or more of the following predatory insects.

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Somatium oviformis (Casey.) (Staphylinidæ, Coleoptera).

This is a small shining black peculiarly shaped rove beetle about 1 mm. long with short wing covers and with the abdomen strongly curved upward. The body is densely covered with short fine hairs. The beetle is an active feeder particularly in its larval stage on the nymphs and adults of the mite. The larva is elongate, about 2·5 mm. long, pinkish-brown or yellowish-brown in colour, tapering towards the anterior end and clothed with short fine scattered hairs. The mandibles are sharp-pointed and curved.

Detailed observations on the mode of attack and feeding by the predator (larval and adult stages) were made. The predator larvæ were found to be more active than the adults and feed more voraciously. They were noticed to successively attack a number of mites one after the other. The predator larva, when it approached a mite, caught hold of it and made a puncture by means of the sharp mandibles, usually on one side of the host body. Then vigorous sucking of the body fluid of the mite began, and in about 5-6 minutes, almost the entire body contents were sucked up by the predator larva, reducing the victim to a pale mass of skin. Immediately after, the sucked up fluid was again forced back into the body of the mite which again became turgid, and then sucked back again, and this peculiar process of alternate regurgitation and sucking in went on for about 2-2½ minutes at the end of which even minute traces of the body fluid of the victim were sucked up by the predator larva ; and the pale whitish crumpled mass of skin of the mite was discarded before the predator larva proceeded to attack another victim. During the process of sucking, the backward and forward movement of the body fluid in the alimentary canal of the predator could be distinctly observed through its transparent integument. Feeding also occurred on the eggs in a similar manner. The adult beetle, on the other hand, was observed to be slow in its movement and not very active in seizing its victims, though it took only 2-3 minutes to finish off one individual (nymph or adult). Sometimes mites seized by the beetles were also observed to get free from the hold of the predator and escape.

S. oviformis was frequently observed in large numbers in association with the red spider mite infesting especially pumpkin, cucumber and cowpea. The absence of the predator on certain other plants like castor and groundnut infested with the mite, at the same time when it was noticed to be abundant on mite infested pumpkin and when these crops were almost adjacent to each other, was an interesting observation.

Stethorus sp. (Coccinellidæ, Coleoptera).

This is another important predatory beetle, usually found in large numbers on certain plants like castor, infested with the red spider

mite. The adult is a small, black oval beetle clothed with scattered, fine hairs. The larva is almost elongate-oval, a little flattened, dark grey in colour and bears minute hairs on the body.

Larvæ and beetles were frequently seen together feeding on all stages of the mite, more particularly the nymphal and adult stages. The victim was seized by means of the mouth parts and was chewed up unlike the sucking process observed in the case of the rove beetle larva. The nature of feeding by the larvæ and adults of the predator was similar. They were seen to be most abundant on mite-infested castor plants and occasionally on cotton and cowpea plants infested with the red spider mite. Even heavy infestations of the mite on castor plants were, at times, noted to be wiped out mainly by these ladybird beetles. During these observations, the Coccinellid was never noticed on pumpkin infested with red mite, though the predator was abundant on adjacent mite-infested castor plants.

Scolothrips sexmaculatus (Pergande.) (Thripidæ, Thysanoptera).

The adult is small, pale yellow in colour with the usual ribbon-shaped, narrow wings fringed with hairs ; the forewing is characterised by the presence of three brown spots. This species was found in small numbers particularly on the mite-infested pumpkin and cowpea plants, though it was not entirely absent on the other host plants infested with the mite. Usually eggs and young ones of the mite were noticed to be attacked by this predator. Unlike the rove beetle larva, the thrips was observed to suck the body fluid of the host successively through a number of punctures made by means of the mouth parts on the host body, all the time manipulating the host body by means of the front legs. It was observed to be a slow feeder, taking 35-40 minutes to complete feeding of one individual (nymph). The entire body fluid of the mite was not sucked up in any case ; however the victim was not observed to survive the attack by the thrips. It was clear from the observations on the feeding capacities and number of individuals present on any mite infestation, that this species was a less efficaceous natural agent in the control of the red spider mite.

In addition to the above species, occasionally, a small yellowish unidentified mite was also observed in very small numbers to feed on the red mite, particularly on the inactive younger stages of the mite.

These preliminary observations on the various plants infested with the red mite, and the natural enemies on the mite indicated that the abovementioned predators, particularly the rove beetle (*S. oviformis*) and the ladybird beetle (*Sthethorus* sp.) together exercised an effective controlling influence in nature on infestations of the red spider mite.

Our thanks are due to Mr. B. Krishnamurti, Government Entomologist, for his guidance and for providing facilities for the above work. We are indebted to the Director, Commonwealth Institute of Entomology, London, for the identification of some of the species included in this paper.

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IRRIGATION AGRICULTURE UNDER TUNGABHADRA PROJECT

By S. Rajarathnam*

I. Introduction

The Ceded Districts comprising of Bellary, Anantapur, Cuddapah and Kurnool are often famine-stricken to varying degrees due to geographical position. The monsoon rains in this tract are low and not properly distributed, the average rainfall being only 22·89". The uneven distribution of rains often results in crop failures causing frequent famines. In order to afford permanent relief from frequent famines, the waters of the Tungabhadra river are being harnessed to provide adequate water-supply for agricultural purposes and generate cheap hydro-electric energy. A dam across the Tungabhadra river is nearing completion at Mallapuram near Hospet.

When the project develops, it is estimated to irrigate about 2,50,000 acres ; comprising of 3 zones, (*a*) perennial zone of 15,000 acres, (*b*) wet zone of 43,000 acres, and (*c*) dry-*cum*-wet zone of 1,92,000 acres. In the perennial zone, water would be available throughout except for a short period of about a month in the year for clearing silt. Paddy and sugarcane can be grown in this zone. In the wet zone, water would be given only for one crop of paddy. In the third zone, dryland crops like jola, *navane*, cotton, etc., will be given water as and when rains fail, such facilities being arranged only for one crop, either in the early or late season. Thus, for wet zone and dry-*cum*-wet zone, water will be available from June to February only for one crop. The entire perennial zone is localised in the three main distributaries situated on the western side of Hagari river to minimise loss of seepage water.

In the new achakat, it may be possible to grow about 7,500 acres under sugarcane and 50,500 acres under paddy; 96,000 acres under food crops like jola, *navane*, etc., and 96,000 acres under money crops like cotton and groundnut.

II. The Project Area

In the first instance, a total area of 2½ lakh acres is expected to be provided with irrigation facilities under the low level canal which runs over a length of 210 miles with the main object of preventing crop failures by giving protected irrigation to rainfed crops.

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The soils in this zone are mostly black soils, red and mixed soils constituting only about 20 per cent. The black soils contain 68 per cent. clay. The soils are rich in lime and possess desirable base exchange capacity. pH varies from 8·0 to 9·5.

Of the 80 per cent. of black soils, 60 per cent. are deep soils (8′-10′) of which 35 per cent. have gypsum and 25 per cent. without gypsum. The shallow black soils (1½′-4′) form the other 20 per cent. of which 2 per cent. are with gypsum and 18 per cent. without gypsum. Where gypsum is present the salt concentration is as high as 1·5 to 2·0 per cent. The surface soil contains salts to about 0·1 per cent., toxic limit being 0·2 per cent. It was feared that the black soils if irrigated might turn alkaline in due course and become unfit for cultivation in the long run as in the case of Nira Valley Scheme of Bombay. Soil survey was conducted in the year 1935 and it was found that the top 3′ (*i.e.*, crop zone) of soils are free from the concentration of salts harmful for plant growth, while subsoils below 3′ are found to contain higher concentration of salts harmful for normal growth.

In order to study the soil reaction caused by movement of salts by irrigation, a compact block of 92 acres was selected at Siruguppa. The research station is 1½ miles from Siruguppa town on the Siruguppa-Adoni Road. The soils of the farm are mostly black and representative of the project achakat. The water required for irrigation on the station is pumped from Siruguppa Channel which is fed by the Tungabhadra river.

III. Chemical Investigations

The movement of water-soluble salts in deep black soils and shallow soils with light irrigation of varying degrees was studied. The treatments were (*i*) no irrigation, (*ii*) irrigation as and when required by the crop (judged by visual observation), (*iii*) irrigation with 2″ of water once in 15 days, (*iv*) irrigation with 3″ of water once in 15 days, and (*v*) irrigation with 3″ once in 30 days.

Cholam M-47-3 and cotton H.A.11 were raised in this trial in the Hingari season (September-October). Soil samples were taken prior to irrigation and after harvest of crops in every year and analysed. The results revealed no indication of the rise of salts to the surface leading to alkalinity. In the case of shallow soils with and without gypsum also, no upward movements of salts were noticed.

The movements of water-soluble salts were studied in medium and shallow soils under puddled conditions with different systems of cropping, *viz.*, (*i*) single crop paddy, (*ii*) double crop paddy, and (*iii*) sugarcane and paddy in rotation, in all the above three systems of cropping, the soluble salts were much less in the post-irrigation

samples compared to the pre-irrigation ones as seen from the following data.

S. No.	Particulars	Soil subjected to light irrigation of two inches in 15 days in deep black soils.	Shallow soils subjected to heavy irrigation in wetlands
		Average percentage of soluble salts in top 3′ of soil	
1	Pre-irrigation sample ..	0·11 (year 1937)	0·63 (year 1939)
2	Post-irrigation sample ..	0·08 (year 1952)	0·11 (year 1952)

It will be seen from the figures given above, that there is no rise of salts and consequent adverse effects but, on the other hand, there is a definite wash down of the soluble salts. So no alkalinity will be formed as a result of irrigation in the black soils of the achakat.

Soil moisture studies were conducted with three treatments, *viz.*, (*i*) no irrigation, (*ii*) 2″ of irrigation once in 30 days, and (*iii*) raiyats' method of irrigation, *i.e.*, irrigating the crop with 2″ of water as and when required as judged by visual observation, to observe the percolation and retention of rainfall and irrigation water applied to black soils. Cotton and jola were grown both under dry and irrigated conditions with fallow plots as controls. Fallow plots under irrigation series, received water as in the case of crops. The data revealed the following : (*i*) the percolation of rainwater to lower layers in dry pots was found to be slow due to the heavy nature of the black soil and once the moisture film got established, the percolation improved gradually, (*ii*) in the case of the irrigated fallow plots, the moisture percentage due to seasonal variations was negligible below 1′, while in the cropped area the depletion of moisture was noticed up to 3′ depth, (*iii*) the loss of moisture in the irrigated plots was chiefly confined to top 1′ only, (*iv*) the percentage loss of moisture in the top layers of the soil was found to be higher in the irrigated plots than in the dry plots, (*v*) the irrigated plots revealed uniform moisture content in all the layers up to the third foot, while in the dry plots the percentage of moisture increased with the depth.

Pot culture studies were undertaken on different crops with sodium chloride to observe the degree of salt tolerance. Different concentrations of salts ranging from 0·05 per cent. to 0·5 per cent. were used in this trial. The results showed that only jola and wheat exhibited greater tolerance up to 0·2 per cent. which is the limit of the saline tolerance for most of the crops in general. It may be mentioned here, that since the salt status of soils at Siruguppa after irrigation being only 0·08 per cent. in dry irrigated area and 0·11 per cent. in wet

lands, these percentage are well within the limits of saline tolerance of the crops usually raised in this tract.

Examination of the Tungabhadra waters revealed that the content of total solids ranged from 9 to 29 parts per 100,000 parts of water and the values were the lowest in the months of July and August when the river is normally in floods and a steady rise was noticed from September to April. It was also observed that even in summer, the concentration of salts was far below the lethal dose for crops. Samples of Tungabhadra river water taken at different places and depths were examined for silt content and the results showed that no differences existed between the silt content of the river and channels fed by the river. The maximum silt content was seen during the floods and the minimum was during the summer.

In short, the chemical investigation revealed (*i*) that both the top 3' of soils and Tungabhadra waters have low salt content, (*ii*) as a result of irrigation given once in 15 days, no appreciable rise of salts was seen, (*iii*) under wetland conditions, the washing down of salts is greater. Thus, the above observations clearly dispel all doubts regarding the development of alkalinity in the black soils as a result of irrigation.

IV. Agronomic Experiments

In order to determine the kinds of crops to be grown, their time of sowing, seed rate, dose of manure, duty of water, rotations and various other cultural details the following studies were made at Siruguppa.

Season and Crops.—With the advent of irrigation, it was found possible to grow with profit not only the existing rainfed crops of the tract like jola, *navane,* cotton, but also other new crops like American cotton, chillies, wheat and maize. There are two crop seasons in the project area, *viz.*, early (Mungari—June to September), and late (Hingari—October to February). Agronomic trials have indicated the choice of the following crops in the respective seasons under dry-irrigated conditions.

Early Season.—Jola, *navane* (*Setaria italica*), groundnut, ragi, redgram, chillies, sweet potato, maize and vegetables.

Late Season.—Cotton, wheat, onions, garlic, *hingari* jola, ragi, sweet potato, chillies, tomatoes and brinjals.

Time of sowing plays an important part in obtaining the maximum yields. At present, this factor is mostly governed by the nature and intensity of the monsoons which are erratic and often fail. With the advent of irrigation, all the crops could be sown in their respective seasons and maximum benefits could be realised. Based on the results

gathered in the time of sowing experiments on the different crops, the following cropping calendar is recommended for the project area.

S. No.	Nakshatras	Corresponding English dates	Crops
1	Mrugasira	7th to 22nd June	Maize and Mungari Jola; Green manure crops such as Sunnhemp, Dhaincha, Sesbania, Greengram, Cowpea and Horsegram
2	Aridra	23rd June to 7th July	Jola, Groundnut, Redgram, Ragi and Sweet Potato
3	Punarvasu	8th July to 23rd July	*Navane*, Ragi, Chillies and *Navane*-Cotton Mixture
4	Aslesha	24th July to 8th August	Groundnut
5	Makha	9th August to 24th August	American Cotton
6	Pubba	25th August to 11th September	..
7	Uttara	12th September to 25th September	Onions, Brinjals, Tomatoes, Nursery and *Hingari* Jola
8	Hasta	26th September to 8th October	..
9	Chitta	9th october to 22nd October	Bengalgram, Onions, transplanting of Tomato and Brinjal, etc.

In the rainfed area, the preparatory cultivation consists of deep ploughing once in 3-5 years only and working with a blade harrow (*Kunte*) 2-3 times every year. Under irrigated conditions, the land has to be ploughed every year 5-6" deep for which an iron mouldboard plough is necessary. Usually 3 ploughings are to be given, the first immediately after the harvest of the crop, the second after the commencement of the monsoon and the third just before sowing. Fields are to be laid out into beds and channels along the contour with the aid of bundformers. Seeds are usually sown with a seed-drill (*Kurige*) and immediately irrigated.

Manuring.—Drylands in this tract are normally manured with farmyard manure once in 3-5 years. Under irrigated conditions, the crops will have to be manured every year. Mere irrigation without manuring did not increase the crop yields appreciably. But, on the other hand, lands continuously cropped under irrigation without manuring gave yields lower than that of rainfed crops. Heavy application of manures like groundnut cake, cattle manure, compost, sheep penning and ammonium sulphate have given very good yields on the irrigated black soils. As the black soils of the tract are deficient, both in nitrogen and phosphorus, the application of manures rich in

these constituents is to be advocated. The black soils are also deficient in organic matter and these will have to be enriched by incorporating crop residues in the soils, after harvest and by growing green manure crops. A sunnhemp crop can be raised in all *Hingari* lands with the help of the south-west monsoon rains which will yield 8,000-10,000 lb. of green leaf per acre. It is advisable to manure the early crop lands with 10 cartloads of farmyard manure and with 5 cartloads of compost per acre. In the early cropped wetlands a mixture of sunnhemp and *pillipesara*[1] can be raised which will give enough green leaf by the time planting of paddy is undertaken. In the double crop wetlands, planting of Sesbania seedlings all along the fieldbunds 6" apart at the time of planting the first crop will yield 2,000-3,000 lb. of green leaf for the second crop area. Green manure alone may not be enough for obtaining maximum yields. Hence, this will have to be supplemented by the application of 40 lb. N per acre in the form of ammonium sulphate drilled prior to sowing for dry-irrigated crops like jola, *navane*, wheat ; 40 lb. of N in the form of ammonium sulphate and 40 lb. P in the form of superphosphate for paddy crop in wetlands. Superphosphate will be better utilised by applying to the green manure crop raised in wetlands by placement of the manure at a depth of 3-4" behind a country plough or iron plough, before sowing.

Irrigation.—Irrigation experiments have shown that the optimum irrigation required for a dry-irrigated crop is only 2" once in a fortnight. According to this schedule, a 4 months' crop will get 8 irrigations in all. But, normally only 4-6 irrigations are given depending on the rains received from the time of sowing to maturity of crops. To facilitate irrigation, the lands will have to be levelled up perfectly for wetland cultivation and to a fair degree in the case of dry-irrigated area. It was found that a flow of 0·25 cusec of water can be managed by one man in normal slopes. Long and narrow beds, *viz.*, 7' wide and 20-30' long depending upon the slope may be formed so that the irrigator can easily handle 0·25 cusec. In the case of wetlands, water will have to be supplied daily, so that the soils do not dry up and crack. Any quantity of water can be handled in wetlands and no serious difficulty has been met with in irrigating paddy lands.

Varieties.—Sufficiently large number of trials were conducted on this station both in the early and late seasons, with a number of varieties in each crop, with a view to find the most suitable one for the project area.

Paddy : Trials conducted so far at the station, revealed that the varieties noted below may be sown in the respective three seasons.

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[1] *Phaseclus trilobus.*

(*i*) June-July to November-December—GEB.24 or AKP.2.

(*ii*) September-October to January-February—ADT 18 or MTU.15.

(*iii*) January-February to April-May—Co.13.

On the station the above strains GEB.24, AKP.2, ADT.18, MTU.15 and Co.13 had given 5,500 lb., 4,500 lb., 2,500 lb., 3,000 lb. and 2,500 lb. paddy per acre respectively. With the advent of the project, it is possible to raise paddy in about 50,500 acres of perennial and wet zones and increased production of food will result in the district.

Green manure is an important adjunct for a successful raising of paddy crop. With the receipt of summer showers the land is ploughed up and manured at 40 lb. of P in the form of superphosphate by placement behind the plough to a depth of about 3-4" in the subsequent ploughing. The field is sown with a sunnhemp crop adopting a seed rate of 30-40 lb. per acre. The crop can be ploughed in after a growth of 45-60 days where as much as 8,000-10,000 lb. of green matter per acre can be obtained. After the incorporation of the sunnhemp crop, it may be allowed to rot well for a few days before planting of paddy seedlings. Top dressing with ammonium sulphate to supply 30-45 lb. N per acre, is to be carired out, 3-4 weeks after planting. Nurseries are raised early in June. The normal seed rate of about 30 lb. of paddy sown in 10 cents of well-prepared and manured beds, will be sufficient for transplanting an acre. A top dressing of 1 lb. of ammonium sulphate per cent. (1/100 acre) of nursery may be applied only when the seedlings are stunted in growth, 15 days after sowing. The transplanting will be taken up with 35-40 days' old seedlings planted at 4" apart as double seedlings in well puddled and levelled fields. There should be sufficient quantity of water in the paddy field throughout the growing period. Frequent strengthening of bunds to repair damage by crabs has to be attended to. 1-2 weedings have to be given in early stages. Strain AKP.2 comes to harvest by the middle of November which is 3-4 weeks earlier than GEB.24. This facilitates the carrying out of preparatory cultivation for the succeeding sugarcane crop if paddy is to be followed by sugarcane. The average acre yields of AKP.2 and GEB.24 are 3,500 lb. and 4,000 lb. respectively.

Sugarcane : The cultivation of sugarcane crop is already in vogue in taluks like Hospet and Siruguppa. Sugarcane varietal trials on the station indicated the suitability of Co.419 for the project area. The rotation suggested for this crop is to raise a sugarcane crop after early sown paddy. After the harvest of paddy by December-January preparatory cultivation for sugarcane is taken up. Two ploughings with Victory plough are usually given. Manuring is

done either by sheep penning at 4,000-6,000 sheep per acre or application of cattle manure or compost at 10-15 tons per acre. In addition to the above basal dressing, 150-200 lb. of nitrogen per acre are added usually in the form of ammonium sulphate and groundnutcake in the ratio of 2 : 1. This mixture may be applied as a top dressing, just before the first earthing up is taken, *i.e.*, when the crop is 3-4 months old. Disease-free sugarcane setts are planted in February-March in furrows opened up at 2'-3" apart. The usual seed rate adopted is 16,000 setts per acre. Systematic irrigation, once in 7-10 days is highly essential. Weedings have to be done whenever necessary and earthing up with ridge plough should be done soon after weeding. The crop matures in about a year and an average yield of 35 tons per acre of cane can be expected.

Jola : This is an important crop of the tract as it forms the staple food of the people. This can be raised both in the early sown crop and late seasons. The season for the early-sown crop is June-July and for the late one, second fortnight of September. The types of jola suitable for the two seasons are distinct. The varieties that are recommended are Co.9 for the early and the Bombay varieties like M.37-2, M.9.S.1-2 and M.47-3 for the late season. The Co.9 variety has dull white grain whereas the late season types are pearly white, the colour which is in great demand. 1 or 2 ploughings followed by a harrowing are generally the preparatory cultivation given to this crop. About 5-10 tons of cattle manure is given as a basal dressing supplemented by ammonium sulphate at 40 lb. N level drilled in beds prior to sowing. The field is then thrown into suitable beds measuring 7' × 25' or 30' depending on the nature of gradient. Jola seed is best sown by drilling, adopting 8 lb. per acre for the early sowing and 15 lb. for the late. Higher seed rate for September sowing is recommended to overcome the heavy damage caused by shoot borer fly (*Atherigona indica*). Fortnightly irrigations are recommended. Since the crops are sown in lines *halube* (harrow) can be worked between rows to check weed growth. The crop matures in about 3½-4 months and yields 1,500-2,000 lb. of grain and about 4,000 lb. of straw per acre. The damage done by bird scaring should be done to prevent loss of grain by birds' attack.

Navane.—The next important cereal crop of this tract is *navane* as it forms the staple food of the people. N.1 and H.1 strains of *navane* are found to be cosmopolitan in habit and thrive well both under rainfed and irrigated conditions. The sowing season is June-July and the crop matures by September-October. The preparatory cultivation, manuring, interculture and irrigation are all similar to that of jola crop. A good crop yields about 1,500 lb. of grain and 2,000 lb. of straw per acre.

Cotton: Cotton is an important commercial crop. The rainfed Deshi type producing low yield and inferior cotton has to be replaced by the high yielding quality cambodia types when the Tungabhadra waters are let in. The trials so far undertaken revealed that types like Lakshmi (Bombay strain) and M.A. II (Mysore American II) are the best for these soils under irrigated conditions. The land is prepared usually by ploughing twice or thrice and manured at the rate of 5-10 tons of cattle manure per acre. Ammonium sulphate at 60 lb. N can be applied. The field is thrown into ridges and furrows 2'-3", 2-3 seeds per hole are dibbled at 9" apart in the row adapting a 10 lb. seed rate. The sowing is usually done by the midlde of August. A top dressing of ammonium sulphate at 60 lb. N level is applied when the crop is 6 weeks old and the plants are earthed up. Fortnightly irrigations are recommended. It is interesting to note that Lakshmi Cotton of Bombay State had yielded as high as 1,400 lb. kapas per acre on the station during 1952-53. Normally cambodia crop yields 800 lb. kapas per acre on average; while a dryland crop Deshi type H.1 yields about 250 lb. kapas per acre. Lakshmi variety matures earlier than other cambodia types; its duration being 210 days. Opening is good. Lakshmi is having staple length of 0·95". It spins up to 45 counts and gins upto 37 per cent. It must be noted that irrigated cambodia cotton is better in quality, fetching a higher price in the market. In the year 1953, Lakshmi kapas fetched a premium of about Rs. 45 per 392 lb. over the rate for H.1, kapas at Adoni market. It pays in the project if cambodia is grown under irrigation due to its higher yield and good price in the market.

Glumed Wheat : Wheat is generally grown late in the season as a *rabi* crop. As there is plenty of time usually a green manure crop is raised and ploughed a month in advance of wheat sowing. In addition to the green manuring, 40 lb. N per acre in the form of ammonium sulphate is also given. The field is cultivated and formed into beds. The sowing is done with Akkadies (hoppers) behind *Kurige* using a seed rate of 60 lb. during second fortnight of October. Weeding and intercultural operations are given to this crop. An irrigation at the time of flowering is very essential. About four irrigations in all are required to mature a wheat crop. The crop comes to harvest in about 4 months. The harvesting is done in the early hours of morning to prevent shedding. The wheat straw is not relished by cattle and can be used for composting.

Bengalgram.—This crop can be raised after the harvest of Mungari jola or *navane*. After the harvest of the early crop, the field is brought to condition and Bengalgram is sown behind country plough. The variety recommended is 482. Though the sowing is done with

the help of moisture in the field it is better to give one irrigation to get higher yields. Immediately after sowing the field is thrown into beds for this purpose. The normal yield is about 400 lb. per acre.

Groundnut-Redgram Mixture.—Though not common to this tract, mixed cropping of groundnut and redgram comes in handy in the adoption of three-year rotation in black soils with jola and cotton. Bunch variety TMV.2 is found to be the best. The usual preparatory cultivation is given to the field and generally this crop is benefited by the residual effects of manuring done to the previous crop. The sowing is generally done after forming suitable beds behind a 6-tyned *Kurige* with Akkadies. Groundnut kernels at 80-100 lb. per acre are sown in the beds and redgram seeds are dibbled on one side of the ridge of the bed using a seed rate of about 2 lb. per acre. The sowing is generally done taking advantage of good precipitation received during the period. Crop matures with two irrigations and the harvest of groundnut pods will be taken up during November and that of redgram during January. The yield of groundnut in normal years is 1,000 lb. and that of redgram 500 lb. per acre.

Fruits and Vegetables : The possibilities of raising of fruit trees in the black soil under irrigation are bright. Among the fruit trees, mention may be made about the successful raising of pomegranates, guava, papaya which seem to take kindly to black soils. Among the vegetables, mention has to be made about the cultivation of tomatoes. As much as 20,000 lb. of tomato fruits have been gathered from an acre. Other vegetables like brinjals, bhendai, cluster beans and gourds come up well under irrigated conditions and yield remunerative returns.

Miscellaneous Crops.—In addition to the above crops, chillies, sweet potato and maize crops have been grown in the farm with encouraging results.

In the Project area, due to the paucity of cattle manure, the manuring of crops will become a major problem for the Project area. Green leaf-yielding plants like *Gliricidia maculata* can be grown along main irrigation channels and roadsides while *Sesbania speciosa* can be planted in the wetlands along the borders without any detrimental effects on paddy. The adoption of the above recommendation to grow such green manure plants will go a long way in solving the manure problem and thereby maintain the fertility of the soil.

For more particulars and details for raising crops successfully in the Project area, the Agronomist, Agricultural Research Station, Siruguppa, may please be consulted.

The cost of cultivation of important crops grown on the Agricultural Research Station, Siruguppa, is given in Appendix No. 1.

Appendix I

Statement showing the average cost of cultivation of various crops grown at Agricultural Research Station, Sirugappa, for the three seasons (1949 *to* 1951)

No.	Crop	Preparatory cultivation	Manures and manuring	Seeds and sowing	After cultivation	Irrigation	Harvest and threshing	Acre yield in lb.	Value of produce	Cost of cultivation	Net profit
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1	Paddy GEB. 24 ..	46 4 0	69 12 0	34 10 0	5 2 0	26 2 0	37 12 0	3252	471 1 3 0	219 10 0	252 3 0
2	Sugarcane ..	65 4 5	91 9 0	167 15 0	64 11 0	31 4 0	169 2 0	4687 (Jaggery)	1223 12 0	589 13 0	633 15 0
3	Jola ..	37 13 7	70 9 8	4 6 4	3 0 2	5 8 10	4 13 9	2017	358 12 0	126 4 0	232 8 0
4	Groundnut and Redgram	21 7 3	15 14 1	27 4	6 5 4	11 12 10	17 11 9	724 / 322	300 1 0	100 8 0	199 7 0
5	Cotton (cambodia)	36 0 0	100 0	10 0 0	13 8 0	15 8 0	18 12 0	770	336 14 0	193 12 0	143 2 0
6	Glumed wheat ..	31 14 0	39 9 8	12 1 0	11 3 1	20 6 3	15 5 0	1699	242 11 0	120 7 0	122 4 0
7	Onions ..	29 0 0	26 0 0	43 8 0	36 0 0	15 8 0	35 0 0	13020	723 5 0	185 0 0	538 5 0
8	Vegetables—Tomato and Brinjals	50 6 8	62 11 4	27 4 8	31 10 8	43 12 0	121 14 0	Tom 19700 / Brinjal 8190	2167 5 0	337 11 0	1829 10 0
9	Maize ..	23 3 4	60 14 0	6 0 0	8 8 0	5 8 0	13 8 0	2894	258 14 0	117 9 0	141 5 0
10	Bengalgram ..	17 3 0	..	9 2 11	1 2 9	2 5 6	6 13 5	350	80 0 0	36 12 0	43 4 0

Glossary

Jola : *Sorghum vulgare.*

Navane : Italian millet, *Setaria italica.*

Achakat : Ayacut : Command area under irrigation works.

Kunte : Blade hoe.

Kuirge : Seed-drill.

Halube : Harrow.—*Ed.*

GROW CAMBODIA COTTON IN THE TUNGABHADRA PROJECT AREA

By S. B. Priyavratha Rao, B.Sc. (Ag.)*

The main dryland crops raised in the heavy black soils of Rayalaseema are cotton and jowar. Cotton is the chief commercial crop of the Ceded Districts. The cotton crop marketed under the trade names of "Westerns" and "Northerns", comprises of one American and four 'deshi' varieties of cotton. These belong to four different botanical species. At present, the entire crop is raised under unirrigated conditions. The varieties like H.1 in "Westerns", and imported 'Gadag' from Bombay, classified under *G. herbaceum* var. *acerifolium* and strain N.14 in "Northerns" falling under *G. arboreum* race *indica,* constitute the bulk of the medium stapled 'deshi' varieties on the heavy black soils. The inferior "Mungari" mainly composed of varieties of *G. arboreum* race *bengalense,* and medium quality "Dharwar American" (*G. hirsutum*) are the types occupying the red and light black soils.

The cambodia types (*G. hirsutums*) are generally superior to "deshis" in more than one attribute. They are high ginners, superior in staple and finer in quality than the "deshi" type. Therefore, cambodia cotton fetch a better price in the market than the locals. With a view to evolve a long-stapled American upland variety suitable for the Tungabhadra Project area, breeding trials are being conducted at the Agricultural Research Station, Siruguppa. The scheme was sponsored by the Indian Central Cotton Committee, Bombay. A large number of collections from India and abroad were tested under irrigated conditions at Siruguppa. Of all the types tested, M.A. II (from Mysore) and Laxmi (from Bombay) proved to be most consistent in yield in all the seasons. M.A. II,[1] though a high yielder, did not register any big improvement either in staple or ginning, over the local. Laxmi (G.1 × CO.2-9-3) is superior to M.A. II and local, both in ginning and staple length. The yield performance and important economic characters of M.A. II and Laxmi are presented in Table I given below.

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[1] In Mysore, M.A. II was replaced by a superior strain—M.A.V. more than 5 years ago and is no longer advocated by the Mysore Depatrment of Agriculture.—*Ed.*

TABLE I

Economic characters of M.A. II and Laxmi

Sl. No.	Particulars	Years				Average
		1949–50	1950–51	1951–52	1952–53	
	I. M.A. II					
1	Kapas yield per acre (lb.) ..	813	649	776	913	788
2	Lint yield per acre (lb.) ..	244	221	248	277	243
3	Ginning per cent. ..	30·0	34·0	32·0	30·3	31·6
4	Staple length (mm.) ..	24·6	24·4	25·0	21·5*	23·9
5	Fibre weight per cm. (10^{-6} Gm.)	1·52	1·59	†	1·47	1·53
	II. LAXMI					
1	Kapas yield per acre (lb.) ..	529	754	813	864	740
2	Lint yield per acre (lb.) ..	185	279	293	320	269
3	Ginning per cent. ..	35·0	37·0	36·0	37·0	36·3
4	Staple length (mm.) ..	27·2	26·8	27·0	23·0*	26·0
5	Fibre weight per cm. (10^{-6}gm.)	1·35	1·62	†	1·24	1·40

* As per new scale.

† Data not available.

It will be seen from the above figures that Laxmi is superior to M.A. II in all the attributes. In addition, Laxmi spins up to 45's (H.S.W.C.), while M.A. II up to 32's only as against 30's of the local. In boll size and boll opening also, Laxmi scores over M.A. II. It may be mentioned here that during 1952-53 season, Laxmi was grown on the farm over an area of nearly 8 acres on a bulk scale. The average yield registered was 1,018 lb. per acre, while the record yield touched up to 1,450 lb. of seed cotton per acre.

Most of the cultivated crops are season bound. They yield their best only when sown in a particular period of the year. Therefore, with a view to find out the best time for sowing cambodia cotton, experiments were conducted at the Agricultural Research Station, Siruguppa. The results gathered in the time of sowing trials revealed that middle of August as the best time for sowing cambodia cotton to get maximum yields. September and later sown batches suffered heavily from jassids. The yields were of low order. The quality of the produce gathered was also poor, because of the high percentage of bad kapas in it.

Nature does not always space her rainfall to the best advantage for growing crops. One good rain at just the right time usually means the difference between a good crop or a failure. This is the case of crops raised under rainfed conditions. To be certain of a good crop, the only method is to supply water by irrigation to crops, whenever it is needed. Under irrigated conditions, the crop yields are assured. Irrigation alone cannot bring about larger improvements in yields. Irrigation combined with manuring and improved seed enhances the yields considerably.

Irrigation experiments were conducted on the Siruguppa Farm to determine the water requirements of different crops and the right time for irrigation. Siruguppa experiments have revealed that 2 acre-inches of water, once in 15 days, as the best irrigation treatment for dry-irrigated crops like cotton, jowar and wheat, etc. Manurial experiments at Siruguppa have shown that a uniform basal dressing of farmyard manure at 5 tons per acre, supplemented by nitrogenous artificial manures (groundnut cake or ammonium sulphate) as top dressing at 40-60 N level per acre are found to be essential for irrigated cambodia cotton to obtain highly remunerative yields. Raising of a green manure crop like sunnhemp or 'daincha', prior to the sowing of cambodia cotton was found to be quite feasible. Green manuring is the cheapest and the most effective way of building up the soil fertility. As an incentive to the project cultivators, the Government have also accorded sanction for the free supply of water to green manure crops for a period of 3 years in the first instance.

Thrips and jassids are the pests that are commonly met with in cambodia cotton during the early stages of crop growth. These can be effectively controlled by spraying the crop either with DDT (Guesarol 550) on H.E.T.P. (0·1 concentration). This remedial measure costs approximately Rs. 5 only per acre (inclusive of cost of the insecticide *plus* labour charges). Among the diseases, Black-arm (*Xanthononas malvaccarum*) is the one that is seen in an epidemic form in certain years. Black-arm takes a virulent form only in years of heavy rainfall. The primary infection can be controlled to a certain degree by resorting to seed treatment, prior to sowing, with "Perenox'. Spraying the crop with "Perenox" is also recommendeed to prevent secondary infection. Types resistant to jassids and Black-arm have been isolated at Siruguppa. They are 1821-1 and 2196-4 respectively. Work on purification and improvement of these types for other economic attributes is under way.

The cultivation of cambodia cotton can broadly be divided into 5 sections. They are (1) preparatory cultivation; (2) seeds and sowing ; (3) manures and manuring ; (4) after cultivation ; and

(5) harvesting. The standard labour requirements for each of these operations are given in Table II.

TABLE II

Abstract

	Operations*	Cattle pairs		Men		Women	
		From	To	From	To	From	To
1	Preparatory cultivation ..	6½	13	11½	21	..	..
2	Manures and manuring ..	4	7½	4	9	8	12
3	Seeds and sowings ..	..	..	..	..	12	15
4	After cultivation ..	1¾	3	5¾	9	14	48
5	Irrigation and drainage ..	..	..	4	6	..	..
6	Harvesting ..	..	..	..	..	25	38
	Total ..	12¼	23½	25¼	45	59	113

* For details *vide* Annexture I.

The cost of cultivation, value of produce and the net profit realised per acre, for four years (*i.e.*, from 1949-50 to 1952-53) are presented in Table III.

TABLE III

Sl. No.	Year	Value of produce in rupees	‡Cost of cultivation in rupees	Net profit rupees	Remarks
		Rs. A. P.	Rs. A. P.	Rs. A. P.	
1	1949–50	210 7 0	84 11 0	125 12 0	The variations seen from year to year are due to differences in yield levels because of seasonal effects and also partly due to the fluctuation in market rates
2	1950–51	211 13 0	100 7 0	111 6 0	
3	1951–52	288 4 0	100 15 0	187 5 0	
4	1952–53	446 13 0*	149 9 0†	296 4 0	
	Average for 4 years	294 4 3	108 14 6	180 2 9	

* Due to the premium offered for Laxmi cotton over that of the locals.

† Due to the increase in the cost of manuring consequent on the rise in the price of G. N. cake after the decontrol of cake.

‡ Includes water cess.

It will be seen from the above figures that cultivation of cambodia cotton under irrigated conditions really brings in high dividends.

Nearly a lakh of acres are expected to be grown to cotton in the Tungabhadra Project ayacut every year. This is estimated to yield 25,000 bales of superior lint per annum, taking the lint yield at the rate of 1 bale of 400 lb. for every 4 acres. India is a deficit country with regard to long-stapled cottons. It imports them from foreign countries to meet the needs of the mill industry. By growing cambodia cotton in the Project area, not only the cultivators stand to gain by way of increased profits, but the increased production of superior lint, goes a long way in reducing the foreign imports of American upland varieties. A cut in foreign imports will result in a saving of the valuable foreign exchange. This could otherwise usefully be utilised for securing modern textile machinery and technical "know-how", for the betterment of the mill industry. Therefore, the ryots in the Tungabhadra Project ayacut are advised to grow cambodia cotton, "Laxmi". The seeds of Laxmi can be had from any of the Taluk Agricultural Demonstrators. A visit to the Agricultural Research Station, Siruguppa, will give ample opportunities to know more about the cropping pattern in the Project in general, and cambodia cotton cultivation in particular.

Annexure I

Standard labour requirements per acre (cambodia cotton, irrigated)

	Operations	Cattle pairs		Men		Women	
		From	To	From	To	From	To
	I. Preparatory Cultivation						
1	Ploughing with Victory plough ..	1½	3	1½	3	..	..
2	Ploughing with medium iron plough ..	2	3	2	3	..	..
3	Ploughing with country plough ..	1½	3	1½	3	..	..
4	Working Guntaka (H. M. or R. E.) ..	½	1	½	1	..	..
5	Working junior hoe ..	½	1½	½	1½	..	..
6	Forming ridges with Ridger ..	½	1½	½	1½	..	..
7	Rectifying ridges ..	..	..	4	6	..	..
8	Digging corners and edges ..	..	..	1	2	..	..
	Total of I ..	6½	13	11½	21	..	..
	II. Manures and Manuring						
1	Loading and carting of F. Y. M. or compost—5 Tons	2	4	2	4	4	6
2	Spreading manure do ..	..	..	1	1½	4	6
3	Covering manure with country plough ..	1½	2½	1½	2½	..	..
4	Working junior hoe ..	½	1	½	1	..	..
	Total of II ..	4	7½	4	9	8	12
	III. Sowing Seeds						
1	Hand dibbling seeds—(9 inches apart)	..	..	..	..	10	12
2	Filling up gaps ..	..	..	..	..	2	3
	Total of III ..	..	..	..	..	12	15
	IV. After Cultivation						
1	Thinning (single plant per hole) ..	..	..	..	..	2	4
2	Hand weeding and hoeing ..	..	..	..	..	10	40
3	Application of manure as top dressing G. N. cake or Ammonium Sulphate 60N/acre	..	..	..	..	2	4
4	Intercultivation and covering manure with junior hoe	¾	1½	¾	1½	..	..
5	Earthing up with ridges ..	1	1½	1	1½	..	..
6	Rectifying ridges ..	..	..	4	6	..	..
	Total of IV ..	1¾	3	5¾	9	14	48
	V. Irrigation and Drianage						
1	Guiding water (from pump) ..	..	..	4	6	..	..
	Total of V ..	..	..	4	6	..	..
	VI. Harvesting						
1	Harvesting—Picking Kapas–per 100 lb.						
	do *(a)* Early picking ..	..	..	..	..	10	15
	do *(b)* Middle picking ..	..	..	..	..	5	8
	do *(c)* Late picking ..	..	..	..	..	10	15
	Total of VI ..	..	..	..	..	25	38
	Grand Total of I, II, III, IV, V & VI ..	12¼	23½	25¼	45	59	113

FARMERS' NOTES AND SUGGESTIONS
A NOTE ON A TRIAL CULTIVATION OF DUTCH VARIETIES OF POTATOES

By N. L. Narasappa

Chokkahalli, Nandi Hobli, Chickkaballapur Taluk, Kolar District

The seed potatoes of Dutch origin mentioned in this note were given to the writer by the Superintendent, Horticulture Department of the Government of Mysore, for a trial in Chickkaballapur area. These were given on 6th December 1952 and planted on 27-12-1952. Twelve varieties of 3 lb. each were planted as cut sets.

2. These were grown by the writer and his nephew, K. R. Surappa, in the village of Jodi Chokkahalli, Nandi Hobli, Chickkaballapur Taluq, Kolar District, situated near 33rd mile on the Bangalore-Chickkaballapur Road, 1 mile away from the 33rd milestone. The altitude of the place is about 3,050′ above mean sea level. The Nandi Hills forming the western spur about 4 miles away, form a good barricade for monsoons. In spite of the hill range, the rainfall in this area is very scanty as it is in the whole of the Kolar District.

Average monthly rainfall for the last 35 years at Chickkaballapur

Month	Inches Cents
January	0·32
February	0·24
March	0·24
April	1·24
May	2·40
June	2·48
July	4·00
August	4·16
September	6·40
October	4·16
November	2·48
December	0·24

The annual rainfall from 1940 to 1952 has been as under :

Year	Inches cents	Year	Inches cents
1940	35·50	1947	21·00
1941	21·75	1948	26·00
1942	22·50	1949	36·00
1943	43·25	1950	29·00
1944	36·50	1951	22·25
1945	26·50	1952	23·00
1946	41·75		

It will be seen from the above statement that the rainfall has been very scanty and steadily decreasing. There were no rains at all from 27-12-1952 to 15-3-1953 during the period the crop was in ground and the water percolation in the wells became precarious, as it approached the month of March. Continued failure of rains for years past has led to complete dependance on wells for irrigation. Water which was available at 20′ underground cannot now be had even at 30′. The wells are now dug to depths never known before, to tap the underground flow.

3. Chickkaballapur is a predominantly potato-growing area, as this is the primary cash crop of the small holder cultivator. The ryot has no other go than to raise this crop as he is not certain of other food crops due to failure of rains.

Nearly half-a-crore of rupees' worth of potato seeds are annually imported from Simla and are absorbed for planting during the winter season from December onwards to end of January. One other crop is also grown during rainy season with the available local seeds and those reaped from Simla during March. The harvest in this case is not satisfactory for want of good seed.

5. The twelve Dutch varieties, along with two checks, Simla and local, were planted for comparison. Appendices A and B show the details as regards duration of crop, cultivation and yields.

6. The yields could have been easily doubled if the plants had been treated in a rich way. The results shown in the statement are what could be obtained with a minimum cost, labour and water within the capacity of an ordinary ryot of limited means.

7. Prior to the Second World War we were importing potatoes from Italy, Sicily and Malta. These used to be first planted round about Bombay and Poona and then grown at Dharwar ; and finally Dharwar seeds used to be brought over and planted round about Chickkaballapur in addition to directly imported seeds. Rangoon seeds also were in good demand for planting. These markets being lost, in their stead, potatoes from Nilgiris, Shillong, Darjeeling, Dehra Dun, Kalka and Simla were tried. Except the Simla variety, the others did not yield good results. So Chickkaballapur area in particular, and perhaps Mysore Plateau as a whole, looks forward only for Simla setts. Simla may be said to be not cent. per cent. but only 80 per cent. satisfactory. Hence the lookout for fresh varieties. And here the Dutch varieties seem to be worth some attention.

8. In between 19th November 1952 to 1st January 1953, 1,00,710 bags weighing 2,01,420 Bengal maunds, or by local weight 5,53,905 md. of seed potatoes were imported from Simla to Chickkaballapur by rail as parcels and 1,600 bags consisting of 3,200 Bengal

maunds in 8 wagons were also imported by goods train. Time taken to move as parcels is 20 days and as goods nearly and over a month. Freight unit for 200 bags of 400 md. by passenger train is Rs. 1,589 and the rate by goods train for the same unit of weight is Rs. 1,066-11-0. The rate per parcel maund (quarter parcel rate) is Rs. 3-15-0 and goods rate is Rs. 2-10-8. The total rail freight paid for parcels is Rs. 7,94,500-0-0 and by goods Rs. 8,533-8-0.

9. An attempt is under foot to grow Patankot potatoes and Chickkaballapur has imported 284 bags for trial cultivation. Incidental and other charges in all including the cost of seeds and transportation by rail comes to half-a-crore of rupees. There are other potato-growing areas like Malur, Srinivaspur, Chintamani, Sidlaglatta, Devanhalli, Hoskote and Bangalore who might consume a similar or greater quantity of seeds from Simla and their total investment may be assumed for the Mysore Plateau as a whole to import to the tune of 4 crores of rupees' worth from Himachal Pradesh.

10. The potatoes grown around Chickkaballapur were having their hayday when exports were open to Colombo and Rangoon. Now that both the markets are lost, the only easily accessible market is Madras. With the rains setting in time in Hassan District about 60 per cent. of the produce is taken away and used as seeds for the rainy season in Hassan area, where Chickkaballapur potatoes yield a richer harvest, each tuber weighing more than a lb. Unfortunately, the Hassan yield cannot be retained as seed setts, but only used for table.

11. *The writer who finds that the cost of Simla seed is rather heavy suggests that import of Dutch potatoes may be considered if they can be obtained at a smaller cost ; and he also expresses his opinion that the difficulty of keeping up a continued cycle of seed supply from outside the State at an enormous cost year after year can be solved by opening a local potato-breeding station, in order to supply the farmers with suitable and selected seed material.*

12. The writer thanks the Superintendent of Horticulture, for having spared him the potatoes for trial, and Sri. Ananda Ramiah, Curator, in particular, for giving him valuable instructions ; and expresses his indebtedness to Sri. Ranganatharao, Agricultural Inspector, and his Fieldmen Sri. Ramiah and Sri. Narasimhia, for constant supervision and guidance during the course of cultivation.

APPENDIX A

DATE OF PLANTING 27/12/1952 DATE LIFTED 15/3/1953 DURATION: 78 DAYS

Variety of Potatoes	Number of tubers and weight		No. of cut setts planted and sprouted	Yield		No. of tubers realized per tuber planted	Weight realized per pound of potato planted	Average No. of tubers grown per plant	Average yield per plant grown oz.	Plot dimensions sq. ft.	Per acre	
	No.	lb.		No. of tubers	lb.						lb.	Maunds
..	33	3	134	400	40	12	13⅓	3	4·75	66	28,400	1,100
2 Meerlander ..	33	3	138	472	46	14	15⅓	3·25	5·33	66	30,330	1,265
3 Bintje ..	26	3	112	342	24	13	8	3	3·5	50	17,600	733
4 Furore ..	36	3	146	675	61	18	20⅓	4	6	77	21,960	915
5 Ultimus ..	29	3	144	424	47	14	15⅔	3·5	5	71·5	28,629	1,193
6 Saskia ..	25	3	105	360	29	14	9⅔	3·33	4	55·25	21,874	911
7 Erdgold ..	25	3	133	538	37	21	12⅓	4	4·5	66	13,320	555
8 Eigenheimer ..	31	5	146	350	28	11	9⅓	2·4	3	71·5	17,058	710
9 No. 1 (Alpha) ..	30	3	141	418	38	14	12⅔	3	4·3	60·5	27,360	1,140
10 No. 2 (Saskia) ..	22	3	110	359	29	16	9⅔	3·2	4·2	57·5	21,874	911
11 Local ..	25	3	176	340	24	14	8	2	2·2	66	15,840	660
12 Simla ..	30	3	130	321	39	10	13	2·5	5·1	74·25	22,880	953

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CROP RECORD

Trial Cultivation of Dutch Varieties of Potato

1	Name and address of the Grower :	N. L. Narasappa, Retired Assistant Commercial Inspector, S.Ry. and K. R. Surappa, Jodi Chokkahalli, Chickkaballapur Taluk, Kolar District, Mysore State														
2	Locality of Planting	Jodi Chokkahalli Village, Nandi, Hobli Chickkaballapur Taluk, Kolar District 3050′ above Sea Level.														
3	Variety and quantity received (3 lb. each veriety)	Profijt	Meerlander	Bintje	Furore	Ultimus	Saskia	Erdgold	Eigenheimer	No.1 Alpha	No. 2 Saskia	Local	Simla	Industrie	Allerfruheste gelbe	
4	Plot dimensions (Square feet)	66	66	49·5	77	71·5	55·25	66	71·5	60·5	57·5	66	74·25	66	60·5	
5	Munure used with quantity:—															
	(*a*) Farmyard manure (*b*) Other Organic Fertilisers	Half a cart load of manure consisting of city sweepings, night soil, trash, and other green leaves. Besides quarter maund groundnut oilcake was put into the ground and ¼ maund groundnut oilcake was given as liquid manure after one month at the time of furrrowing and weeding														
6	Soil type:—(*a*) Loam, (*b*) Sandy loam, (*c*) Sand	Red Loamy sandy soil														
7	Method of planting: Cut setts	Planted on 27—12—1952.														
8	Weight planted	3 lb. each variety planted														
9	Number of cut setts	134	138	112	166	144	105	133	146	141	110	176	130	140	138	
10	Distance of planting	Six inches apart × 12″														
11	Sprouting date: (*a*) good, (*b*) poor, (*c*) bad 6-1-53	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Poor 10–1–53	Good10–1–53	Good	Good	
12	Number sprouted	134	138	112	166	144	105	133	146	141	110	106	120	140	138	
13	Percentage of germination	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	62%	92%	100%	100%	
14	Method of cultivation	Six inches apart in trenches a foot wide and nine inches deep														
15	Irrigation: Well	Well by electric pump														
16	No. of Irrigations per week	1st week only one irrigation, up to 2–2–53, once in 4 days, up to 20–2–53, once in 3 days and beyond every alternate day														
17	Average height and spread of plants	Height	Spread	H	S	H	S	H	S	H	S	H	S	H	S	H	S	H	S	H	S	H	S	H	S	H	S
	(*a*) after 30 days, (*b*) after 60 days, (*c*) when ready for lifting	7″	5″	6″	2½″	7″	2½″	6½″	3½″	6″	3″	7″	3″	2½″	5″	8″	8″	7″	5″	8″	5″	3″	3″	6″	5″	6″	8″	1″	3″
18	General description of the stand as compared with the local crop:															
	(*a*) Very vigorous, (*b*) Robust, (*c*) Average	Robust	Very vigorous	Poor	Very vigorous	Very vigorous	Average	Average	Average	Average	Average	Poor	Average	Good	Good	
19	Pathological Notes: Insect pests, general measures adopted if any	Gammexane D. 025 one in 6 parts of ash containing 5% was dusted in the very early hours of morning when thick dew had collected on the leaves in the morning, as a preventive measure. No pests or parasites attacked the plants														
20	Date of lifting	15–3–53	15–3–53	15–3–53	15–3–53	15–3–53	15–3–53	15–3–53	15–3–53	15–3–53	12–3–53	27–3–53	27–3–53	15–3–53	15–3–53	
21	Actual yield (in lb.)	40	46	24	61	47	29	37	28	38	29	24	39	45	36	
22	Yield per acre (in lb.)	26,400	30,330	17,600	21,960	28,629	21,874	13,320	17,058	27,360	21,874	15,840	22,880			
23	Brief description of the tubers: (*a*) Size, (*b*) Shape, (*c*) Colour, etc.	White round	Light yellow oblong	Cream round	Pink skin flesh white	Pink skin yellow flesh	White long	Cream oblong	Yellow skin flat oval	White long	White long	Cream round	Cream oblong	Cream egg shape	Cream round shape	
24	Keeping quality	Seed quality	Seed quallty	Seed	Seed	Seed	Seed	Seed	Seed	Seed	Seed	..	..	Seed	Seed	
25	Table quality	..	..	..	..	..	..	..	..	..	Table	Table	..	..	—	
26	Remarks	Please see detailed report on the subject.														

52/2. P.C